Lambda DG-4
and
Lambda DG-5

Ultra-High-Speed Wavelength Switching Illumination System

Operation Manual

Rev. 3.05B (20131009)

SUTTER INSTRUMENT

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CE

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DISCLAIMER

The ultra high speed wavelength switching xenon arc lamp Lambda DG-4/5 system is designed for the specific use as a microscope illuminator and optical wavelength switcher, and no other use is recommended.

This instrument should only be used in a laboratory environment for use on animal tissues. It is not intended for, nor should it be used in, human experimentation or applied to humans in any way. This is not a medical device.

Do not open or attempt to repair the instrument without expressed and explicit instructions from Sutter Instrument Company. Extreme heat and high voltages are present and could cause injury.

Do not allow unauthorized and or untrained operatives to use this device.

Any misuse will be the sole responsibility of the user/owner and Sutter Instruments assumes no implied or inferred liability for direct or consequential damages from this instrument if it is operated or used in any way other than for which it is designed.

SAFETY WARNINGS AND PRECAUTIONS

Electrical

- **Operate the Lambda DG-4/5 using 110-120 V AC, 60 Hz, or 220-240 V AC., 50 Hz line voltage. This instrument is designed for connection to a standard laboratory power outlet (Overvoltage Category II), and because it is a microprocessor--controlled device, it should be accorded the same system wiring precautions as any 'computer type' system. A surge protector and power regulator are recommended.**
- **Fuse Replacement: Replace only with the same type and rating:**
  5 x 20 mm glass tube, time delay (medium), time lag, or "slow blow")
  Rating:

Xenon Lamp Power Rating	Line Voltage: 100 - 120VAC (Voltage Switch Setting: 110V)			Line Voltage: 220 - 240VAC (Voltage Switch Setting: 220V)		
	Fuse Rating	Manufacturer Examples RoHS Compliant (Lead Free)?		Fuse Rating	Manufacturer Examples RoHS Compliant (Lead Free)?	
		Yes	No		Yes	No
125 Watts[1]	3.0A, 125V	Bussmann: GMC-3-R Littelfuse: 239 003.P	Bussmann: GMC-3A Littelfuse: 239 003	T2.0A, 250V	Bussmann: S506-2-R Littelfuse: 218 002.P	Bussmann: GDC-2A Littelfuse: 218 002
175 Watts	4.0A, 125V	Bussmann: GMC-4-R Littelfuse: 239 004.P	Bussmann: GMC-4A Littelfuse: 239 004	T3.15A, 250V	Bussmann: S506-315-R Littelfuse: 218 3.15P	Bussmann: GDC-3.15A Littelfuse: 218 3.15
300 Watts	5.0A, 125V	Bussmann: GMC-5-R Littelfuse: 239 005.P	Bussmann: GMC-5A Littelfuse: 239 005			

A spare fuse is located in the power input module. Please refer to the fuse-replacement appendix for more details on fuse ratings and for instructions on how to change the fuse.

[1] NOTE: The 125-Watt lamp version of the DG-4/DG-5 is a discontinued product.

Avoiding Electrical Shock and Fire-related Injury

- Always use the grounded power supply cord set provided to connect the unit to a grounded outlet (3-prong). This is required to protect you from injury in the event that an electrical hazard occurs.
- Do not disassemble the unit. The only user serviceable parts are the line fuse, the xenon bulb, and filters. The line fuse is accessible from the outside of the unit. The bulb and the filters are accessible via separate panels on the side of the unit. Bulb replacement and filter installation/removal are covered in separate sections of the manual and should only be attempted with the power cord disconnected.
- To prevent fire or shock hazard do not expose the unit to rain or moisture.

Electromagnetic Interference

To comply with FDA and CE electromagnetic immunity and interference standards; and to reduce the electromagnetic coupling between this and other equipment in your lab always use the type and length of interconnect cables provided with the unit for the interconnection of one or more filter wheels and/or shutters, host computer via serial RS-232 or parallel interface, or other equipment via TTL connections (see the TECHNICAL SPECIFICATIONS appendix for more details).

Operational

- Operate only in a location where there is a free flow of fresh air on all sides. NEVER ALLOW THE FREE FLOW OF AIR TO BE RESTRICTED.
- Do not operate the lamp in an orientation where the output of the CERMAX lamp faces within 45° of straight upward. To do so may cause arc instability and the possibility of damage to the front window of the CERMAX lamp. Note that the lamp output is towards the heat sink mounted on the side of the cabinet.

Avoiding Physical Injury while Powered Up and Emitting Light

- WARNING: DO NOT LOOK DIRECTLY INTO THE LIGHT GUIDE! The output of the light aperture or the light guide should be directed into the microscope using the appropriate adapters, directed away from anyone's eyes, and not directed toward any reflective surface.
- INFRARED RADIATION: The infrared radiation (and ultraviolet radiation) generated by this lamp can cause significant skin burns and eye damage.
- THE SMARTSHUTTER IS NOT A SAFETY SHUTTER: The Lambda DG-4 and DG-5 can be optionally equipped with a Sutter Instrument *Smart*Shutter. The SmartShutter is not intended to be a 'safety shutter.' A safety shutter usually closes automatically in the event of a power failure and is designed with the primary goal of ensuring that it will not allow any unintended exposure. For laser safety applications, a

shutter is normally designed so that no single component failure allows an unintended exposure to the laser beam. The SmartShutter is intended for use in the controlling of light in scientific and industrial applications. The SmartShutter was designed for high performance and durability, but without certain features that would be desirable in a safety shutter application.

- EXPLOSION: High internal pressure exists in any xenon arc lamp.
- HIGH VOLTAGE: High ignition voltages, which exist inside the cabinet, can be lethal.
- WARNING: OZONE: The UV-enhanced ("full spectrum") version of the xenon arc bulb generates significant amounts of ozone, which is toxic. A Lambda-DG4/DG5 installed with a full spectrum bulb must be connected to a ventilation or ozone-removing system (also known as an "ozone eater") for the evacuation of the ozone produced during operation. Please contact Sutter Instrument (+1-415-883-0128 or info@sutter.com) for further information. There are no ventilation requirements for the ozone-free bulb.

Avoiding Physical Injury and Equipment Damage while Replacing the Xenon Bulb

WARNING: Before removing the xenon arc lamp bulb housing assembly from a Lambda LS or Lambda DG-4/5 system, make certain that the system is powered down (single switch for the Lambda LS or both MAIN and LAMP switches for the Lambda DG-4/5) and disconnect the power cord from the source. Wait at least half an hour for the lamp to cool before removing the lamp bulb housing.

The original manufacturer of the xenon lamp and power supply used in the Lambda DG-4/5 provides the additional safety information on the following page. It is intended to amplify the information given above.

PerkinElmer Optoelectronics
44370 Christy Street
Fremont CA 94538
Phone: 510-979-6500
FAX: 510-687-1152

OPERATING HAZARDS

CERMAX® Lamps

Read the following instructions and take all necessary precautions

SHORT ARC XENON LAMPS AND SYSTEMS

Proper use and safe operating practices are the responsibility of equipment manufacturers who incorporate the lamp into equipment and users of such lamps and equipment. The supplier of this lamp provides information on its products and associated hazards, but it assumes no responsibility for after-sale operating and safety practices. All lamps are under pressure and must be handled with care. Take appropriate action through baffles, light shields, interlock switches or other safeguards to protect personnel from harm due to operation and/or failure of the lamp.

SAFE OPERATING INSTRUCTIONS

Do not operate this lamp except in accordance with proper operating instructions and within recommended operating specifications. Direct questions regarding lamp operation or safety to your lamp supplier.

LAMP DISPOSAL

CERMAX lamps do not have reclaimable parts. Before disposal, it is recommended to relieve a lamp's gas pressure by squeezing the tip-off with pliers until the gas escapes. If gas pressure is not relieved, care should be taken to discard the lamp in a landfill and not an incinerator.

SAFETY HAZARDS

The operation of lamps involves one or more of the following hazards. In the absence of safe operating practices and precautions, any one of these hazards could result in injury.

I. EXPLOSION - The lamps are filled with xenon gas at very high pressure. Lamps must be handled with the same care and caution given any vessel containing these levels of pressure. A hazard exists if the window or ceramic fractures and may cause explosive mechanical failure. Face shields or proper safety glasses are recommended during all handling operations.

II. HIGH VOLTAGE - Ignition voltage of some lamp models is very high and can be deadly. If portions of the circuit are exposed, caution must be used in setup and operation of the system. The input power must be disconnected from the power source before attempting any service to the lamp.

III. INFRARED AND ULTRAVIOLET RADIATION - Do not look directly at operating lamps orb reflected light. Infrared and ultra violet radiation generated by the lamp can cause skin burns and permanent eye damage.

IV. OZONE - Some UV type lamps generate ozone, a toxic gas, by virtue of the ultraviolet radiation. A lamp which gives off ozone must be operated in a well ventilated area..

V. HOT SURFACES - Portions of the lamp can reach temperatures of several hundred degrees centigrade and cause serious burns if touched even after the lamp is turned off.

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1. GENERAL INFORMATION

1.1 Introduction

The Lambda DG-4 and Lambda DG-5 are two models of an illumination system that is designed for the rapid change of wavelength. The system comprises three subsystems: controller, optical path, and lamp light source with power supply. All three subsystems are conveniently housed in one cabinet. For the most part, this manual is organized around those subsystems to provide you with ready access to information, as you need it. Separate documentation for the lamp and its power supply (provided by PerkinElmer Optoelectronics) accompanies this manual.

1.1.1 How to Use this Manual

This manual is organized in a manner that is best suited for the typical manner in which the reader would learn about the system, and then install, operate, and maintain it. Prior to the table of contents of this manual is a disclaimer and a series of cautionary and warning notes that should be read first. This first chapter provides an overall description of the system, leaving more in-depth technical information towards the end of the chapter. The next chapter describes how to install the system, followed by one or more chapters that provide operation instructions, and ending with a chapter on maintenance. Following the final chapter are several appendices that provide supplemental information. The installation chapter covers everything related to installation, from unpacking the equipment as received, through to ensuring that everything is correctly installed and is operating correctly. The operation chapters cover the two basic types of user interaction with the system: Manual (local) control and external computer control. Please take the time to read these instructions to assure the safe and proper use of this instrument.

1.1.2 Technical Support

Unlimited technical support is provided by Sutter Instrument Company at no charge to our customers. Our technical support staff is available between the hours of 8:00 AM and 5:00 PM (Pacific Time) at **(415) 883-0128**. You may also E-mail your queries to info@sutter.com.

1.2 General Description

The Lambda DG-4/5 is a complete illumination and rapid wavelength switching system. While retaining the advantages of traditional interference filter based systems, the DG-4/5 greatly improves upon the temporal constraints of traditional filter changing devices like filter wheels. With a switching time between adjacent filters of 1.0milliseconds, the DG-4/5 allows for the user to perform real-time video imaging. This high switching speed of the DG-4/5 provides for the ability to follow fast changes in ion concentrations in dual wavelength ratio imaging applications and to monitor other concomitant changes in the studied system at additional wavelengths.

Modern interference filters, as used in the Lambda DG-4/5 do not pass harmonics and have integral blocking characteristics 1000 times better than typical monochromators systems. For the same full width at half maximum (FWHM), interference filters have a narrower spectral bandpass than monochromators due to the absence of the slit function. The dual

galvanometer design of the Lambda DG-4/5 allows tuning of the relative intensities at each wavelength. This adjustment is difficult to obtain in variable wavelength devices with a single optical path. Unlike monochromators and other wavelength selective systems, the Lambda DG-4/5 can be used as a source of white light when required.

The optical path subsystem in the Lambda DG-4/5 is arranged so that 2 mirrors, each mounted on a fast closed-loop servoed galvanometer, can route the collimated output of the lamp through one of 4 or 5 optical paths (e.g., filter position 1 in the diagram below). Slide-in filter holders allow 25 mm (1 inch) diameter filters to be introduced in each of the four optical paths. An additional slide-in filter holder, intended for neutral density filters, is located in a portion of the optical system common to all light paths. After passing through the filter positions, the lamp output is focused on a 2-meter long UV (ultraviolet) transmitting light guide, which acts as a conduit for the output to the microscope. At the output of the light guide, an optical adapter collects the output and delivers it to the microscope.

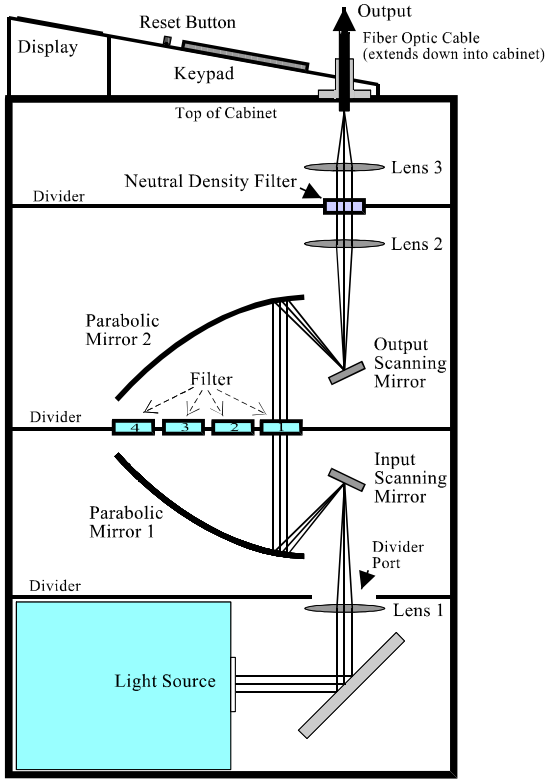

Figure 1-1. Lambda DG-4/5 optical pathway.

Switching between adjacent filters is achieved in 1.0 milliseconds, allowing the user to perform real-time video imaging including facilitating the ability to follow fast changes in ion concentrations in dual wavelength ratio imaging applications, and to monitor other concomitant changes in the studied system at additional wavelengths. The DG-4/5 can also be used as a source of white light when required.

Included with each system is a set of four slide-in filter holders. If you wish to quickly replace any installed filter from a set of many filters, you may wish to order additional slide-in filter holders.

1.2.1 Lambda DG-4 and Lambda DG-5

Throughout this manual, unless otherwise noted, all references and descriptions pertaining to "Lambda DG-4" (or just "DG-4") apply equally to the Lambda DG-5. The only difference between the Lambda DG-4 and Lambda DG-5 is the set of light interference filter holders, as follows:

- **The Lambda DG-4 filter set consists of four 25mm (1-inch) diameter filter holders.**
- **The Lambda DG-5 filter set consists of three 18mm and two 25mm (1-inch) diameter filters holders.**

Both models of the Lambda DG series are calibrated at the factory according to each one's filter holder set arrangement.

1.2.2 Systems

The basic DG-4 system consists of the Lambda DG-4 cabinet, lamp bulb, four slide-in filter holders (25mm), one neutral density filter holder, spanner wrench, liquid light guide, power cord, serial and parallel cables, and manual. The following list provides more detail of the system's contents based on model.

A basic DG-5 system is the same as a basic DG-4 system with the exception of having three 18mm filter holders and two 25mm filter holders.

DG-4/OF: Basic DG-4 system with 175-Watt ozone-free xenon arc bulb.

DG-4/OF300: Basic DG-4 system with 300-Watt ozone-free xenon arc bulb.

DG-4/FS: Basic DG-4 system with 175-Watt full spectrum xenon arc bulb.

DG-4/FS300: Basic DG-4 system with 300-Watt full spectrum xenon arc bulb.

DG-5/OF: Basic DG-5 system with 175-Watt ozone-free xenon arc bulb.

DG-5/OF300: Basic DG-5 system with 300-Watt ozone-free xenon arc bulb.

DG-5FS: Basic DG-5 system with 175-Watt full spectrum xenon arc bulb.

DG-5/FS300: Basic DG-5 system with 300-Watt full spectrum xenon arc bulb.

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2. INSTALLATION

2.1 Unpacking

The Lambda DG-4/5 and associated hardware comes packed in a single carton. The following is a list of the components found there. If you believe that any of these components are missing or show obvious signs of damage from shipping, please contact the factory.

- **Parallel Interface Cable**
- **Serial Interface Cable**
- **Power Cord**
- **4 Individual Filter holders with retaining rings, spacer rings and blanking discs**
- **Neutral Density holder retaining ring, spacer ring and blanking disc**
- **Spanner Wrench**
- **Liquid Light Guide**
- **Manual**
- **Microscope adapters (if ordered)**

2.2 Getting Started

1. Connect the power cord to the socket on the back panel of the Lambda DG-4/5. Make certain that the voltage selector next to the power cord socket has been properly preset to the appropriate voltage (110 or 220). Do not turn on the power, yet.
2. Insert either end of the light guide into the port on the top panel of the Lambda DG-4/5 cabinet (see below) and tighten the thumbscrew to hold it in place. The top of the light guide end sleeve should be flush with the top surface of the port fitting (see below). This should result in maximal or near-maximal light output from the light guide. Minor adjustments up from this position may improve output, and can be easily made once the system is fully installed.

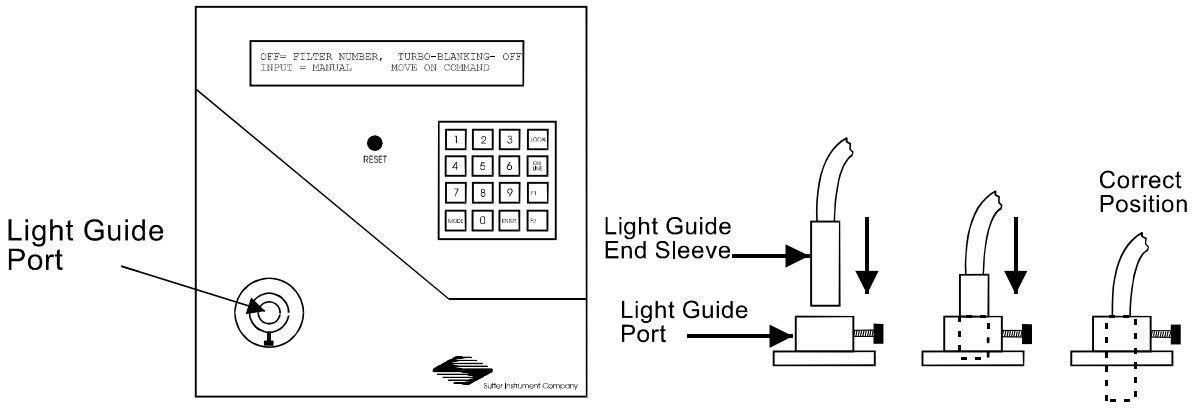


Figure 2-1. Light guide installation.

3. The other end of the light guide should be installed in the microscope using the appropriate adapters (see the installation sheet provided with the specific adapter that

has been ordered) or directed away from anyone's eyes and toward a non-reflective surface. DO NOT LOOK DIRECTLY INTO THE LIGHT GUIDE!

4. A hose should be connected to the 4" fitting on the back of the Lambda DG-4/5 cabinet to ventilate the ozone from the xenon lamp to the environment or to an ozone removal device.
5. Identify the small access door used to install the neutral density FILTER HOLDER. This access door is located near the top edge of the left side panel on the Lambda DG-4/5 cabinet (see below). Loosen the black knob on the access door and slide it up to install the empty Neutral Density FILTER HOLDER (the neutral density FILTER HOLDER is the one whose bottom surface is flat rather than grooved). Make certain that the end nearest the filter cup goes in first. If you would like to install a neutral density filter at this time please refer to the "Loading Filters" section of this manual.

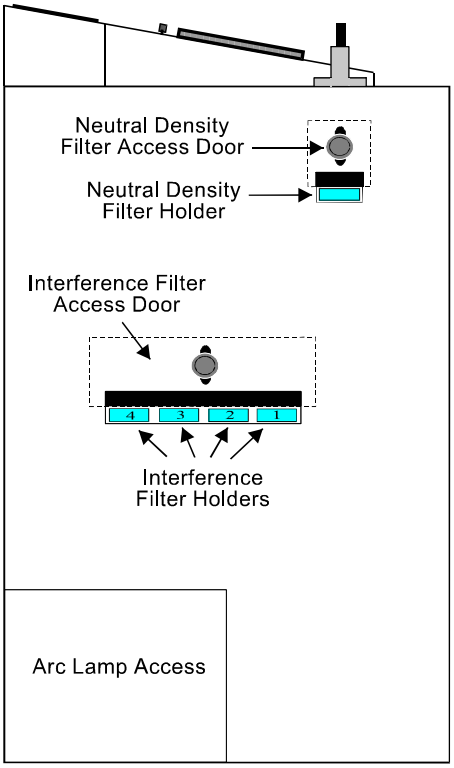
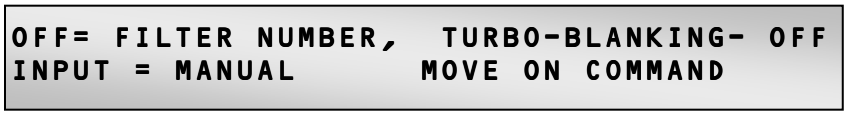


Figure 2-2. Lambda DG-4/5 left side.

6. Identify the large access door used to install the interference FILTER HOLDERS. This access door is located in the middle of the left side panel on the Lambda DG-4/5 cabinet (see above). Loosen the black knob on the access door and slide it up to install the remaining four FILTER HOLDERS (the ones that have a groove on their bottom surface). Install the two FILTER HOLDERS that contain blanking disks in FILTER POSITIONS 3 and 4. If you would like to install interference filters at this time, please refer to the "Loading Filters" section of this manual.
7. Make certain that the free end of the light guide is installed into the microscope or is directed toward a non-reflective surface and away from anyone's eyes. DO NOT LOOK DIRECTLY INTO THE LIGHT GUIDE.

8. Turn on the power to the lamp subsystem using the switch labeled LAMP on the back panel of the Lambda DG-4/5 cabinet. Due to the current draw during lamp ignition, it is important to power up the LAMP first (before the MAIN switch is turned on) to avoid damage to the circuitry of the other Lambda DG-4/5 subsystems. This same precaution applies to the order in which you power up other electronic and computer equipment that might be powered from or grounded to the same circuit as the one used for the Lambda DG-4/5. GO DIRECTLY TO THE NEXT STEP! DO NOT OPERATE THE LAMP FOR MORE THAN A FEW SECONDS WITHOUT TURNING ON THE MAIN POWER SWITCH!
9. Within a few seconds of turning on the LAMP switch turn on the power to the optical path and controller subsystems using the switch labeled MAIN on the back panel of the Lambda DG-4/5 cabinet. The Lambda DG-4/5 will boot up and briefly display the initialization screen followed by the MAIN MENU (shown on top of next page).



10. The Lambda DG-4/5 is under LOCAL (keypad) control upon start-up, as indicated by the words “INPUT - MANUAL” on the MAIN MENU (see above). MOVE ON COMMAND is the active operational mode at start-up, which means that filters are selected by pressing the numeric keys corresponding to the desired FILTER NUMBER (see EDIT A FILTER NUMBER definition of this value). The default FILTER NUMBER upon start-up is “0”. This setting will disrupt the optical pathway within the Lambda DG-4/5 and prevent any light output at the light guide port. The “0” FILTER NUMBER serves, then, as a “shutter” whenever it is selected.
11. Press the “1” key followed by ENTER. This FILTER NUMBER is pre-programmed at the factory to cause the light to be directed through the FILTER HOLDER that is loaded into position 1 and then onto the light guide with maximal light output (i.e., minimal attenuation).
12. Now experiment by selecting FILTER NUMBERS 0 through 4. Anytime you select a single digit FILTER NUMBER you must complete the entry by pressing the ENTER key or you must precede the single digit with a “0”. FILTER NUMBERS 0,1,2,3 and 4 are pre-programmed to correspond with the closed “shutter” and the four FILTER POSITIONS (with minimal attenuation), respectively.

Now that you have completed the “Make it Glow” section of the manual, you should be familiar with the basic components and operation of the Lambda DG-4/5. To get set up for an experimental application you will need to:

- **Install the LIGHT GUIDE into the OPTICAL HOLDER (if not already in place).**
- **Install the OPTICAL HOLDER into the microscope using the appropriate adapter (if not already in place).**
- **Install the desired filters into the FILTER HOLDERS (if not already in place).**
- **Program the desired FILTER NUMBERS.**
- **Establish the desired interface between the Lambda DG-4/5 and your computer.**

Each of these steps is discussed in the following sections of the manual.

2.3 Light Guide & Optical Holder Installation

2.3.1 Liquid Light Guide

The light output of the Lambda 10 DG4 is focused onto one end of a liquid light guide. The output of the liquid light guide can then easily be coupled to your microscope or optical system using correct mechanical adapter for your microscope. Please note that the light guide has a minimum-bending radius of 40 mm (about 1.6 inches).

2.3.2 Liquid Light Guide Installation

The liquid light guide should have black sleeves over the ferrules on both ends. These ferrules, or “end sleeves”, are designed to slide into the mounting flange on the lambda DG-4/5 cabinet and the output adapter. Insert the end of the light guide into the light guide port until the top of the black end sleeve is even with the top of the light guide port. Tighten the locking screw on light guide port to secure the end of the light guide in position. This should result in maximal or near-maximal light output from the light guide. Minor adjustments up from this position may improve output; the adjustments can be easily made once the system is fully installed.

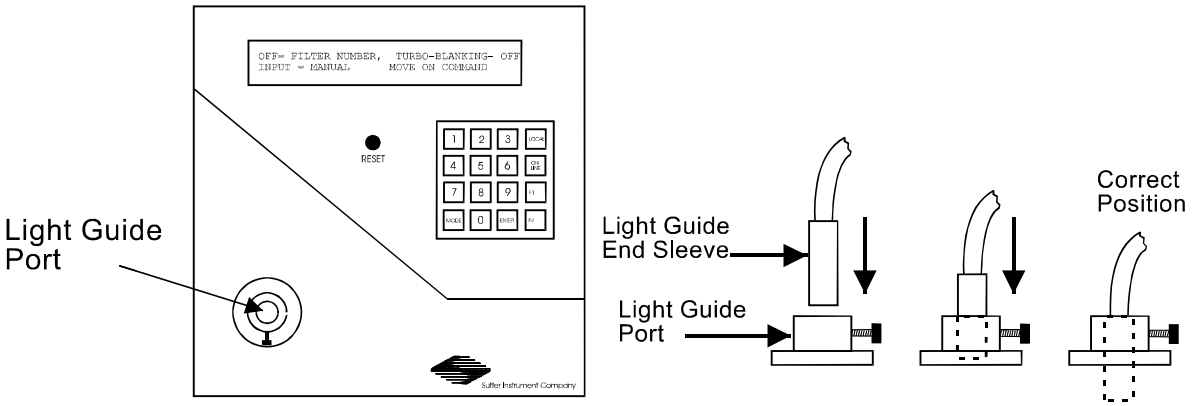


Figure 2-3. Liquid light guide installation.

2.3.3 Optical Holder

The free end of the light guide slides into one end of the optical holder tube (shown below). The other end of the optical holder tube has a UV grade fused silica lens system (in the “short cup”). By sliding the light guide toward or away from these lenses, the light guide output can be collimated or brought to a focus. The optical holder, in turn, slides into the dovetail adapter, which has a “dovetail” collar on one end. This collar is used to fasten the entire assembly to the microscope system using an adapter (not shown) that is specific to the microscope make and model. Refer to the documentation included with each microscope adapter for further installation instructions.

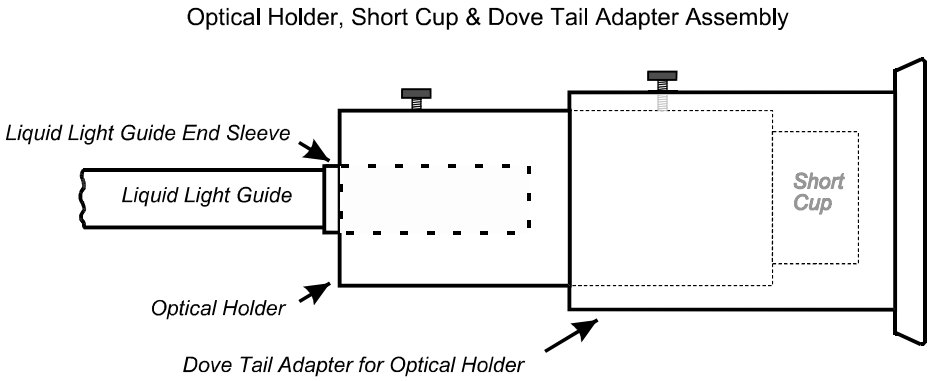


Figure 2-4. Light guide optical holder.

2.4 Loading Filters

2.4.1 Filter Orientation

The two sides of a filter are usually not identical due to differences in their surface coatings. Some form of labeling will be present to differentiate the two sides. It is important to refer to the filter manufacturer's documentation to interpret the labeling and determine the proper orientation relative to the light source. Remember, the light path inside the Lambda DG-4/5 travels from BOTTOM TO TOP. Therefore, the filters should be oriented with their "Lamp Side" down.

2.4.2 Loading Filters

At the end of each filter holder is a filter cup assembly (shown below). There are at least two items installed into the filter cup at the factory: a threaded retaining ring and a spacer ring (to carry the force of the retaining ring to the unthreaded portion at the bottom of the cup). In two of the filter cups, there will also be a blanking disc. Installation of filters into the filter holders requires care and patience to avoid damaging the threads of the filter cups and retaining rings as well as the filters.

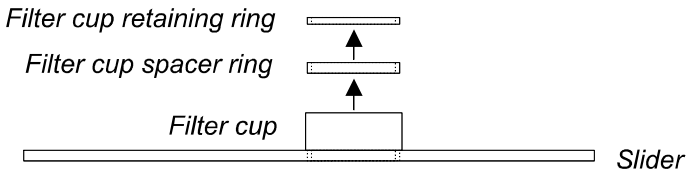


Figure 2-5. Filter holder assembly.

The threaded retaining ring has two notches cut into it, 180 degrees apart. Place the notched end of the brass spanner wrench into the notches on the retaining ring and carefully unscrew it. If a retaining ring has been previously over-tightened, it is possible that the filter cup will begin to unscrew from the slider. If this occurs, STOP. Turn the spanner wrench around and, using the other end, insert it into the slots at the top of the cup. Then screw the cup back into the slider. DO NOT push on the cup. Just screw it in until it seats firmly. It should then be possible to remove the retaining ring.

Once the retaining ring is removed, the spacer (and blank, if present) should fall out. You should become familiar with the assembly of this retaining system. In particular, you should

develop a feel for tightening the retaining ring without pushing on the wrench. This is important because if you forcefully push on the filter holder while you are trying to load a filter, you run the risk of scratching the filter.

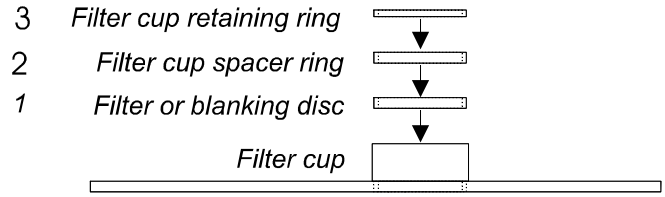


Figure 2-6. Filter holder assembly with blanking disc.

Place the desired filter into the filter cup, first. With some 1" filters extra care must be taken to avoid getting the filters jammed at an angle inside the filter cup.

Next, install the spacer ring into the filter cup. Unless the filter thickness precludes the use of the spacer ring, always install the spacer to provide maximum separation between the filter surface and end of the brass spanner wrench that is used to turn the retaining ring.

Finally, install the threaded retaining ring.

CAUTION: DO NOT OVER TIGHTEN THE RETAINING RING!

2.4.3 Selection of a Filter Position

In most cases, any given filter could be installed at any of the four FILTER POSITIONS. However, some minor considerations may improve performance of the system. Adjacent FILTER POSITIONS will require slightly less switching time. Therefore, if an experiment will require rapid switching between two filters they should be located next to one another. If separated by one or more filters, there will be brief transitions through the intervening filter(s) unless the TURBO-BLANKING feature is enabled (see "Modes of Operation"). While this feature eliminates the transmission of light at unwanted wavelengths, it does further increase the time required for switching.

2.4.4 Blanking Discs

The blanking discs should only be removed from those positions that will contain a filter. The discs are intended as a safety device for the occasion where you may be looking into the microscope. We strongly urge that the discs be used. Please be careful and avoid the possibility of direct visualization of high intensity light.

2.4.5 Neutral Density Filters

. Filter installation is the same for this filter holder as described above. The slide portion of the neutral density filter holder, however, is mechanically different from those used for the interference filters. As a result, the two types of holders may not be interchanged.

2.4.6 Filter Holder Installation

Identify the access doors used to install the neutral density FILTER HOLDER and the four interference FILTER HOLDERS. The small access door located near the top edge of the left side panel on the Lambda DG-4/5 cabinet (see below) is for the neutral-density FILTER HOLDER. The larger door in the middle of the left side panel is fro the interference FILTER

HOLDER. Loosen the black knob on these access doors to slide them up and install the appropriate FILTER HOLDER into the slot. The bottom of the neutral density FILTER HOLDER is flat while the bottoms of the interference FILTER HOLDERS are grooved. For this reason, these two types of FILTER HOLDERS are not interchangeable. Make certain that the end nearest the filter cup goes in first.

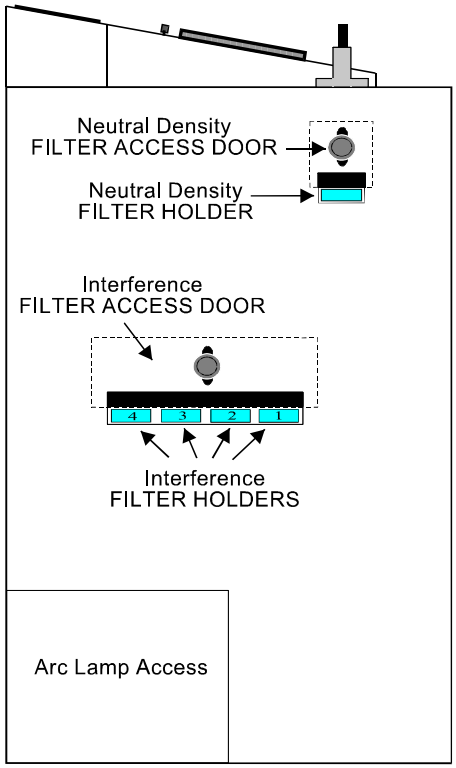


Figure 2-7. Lambda DG-4/5 left side.

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3. OPERATIONS

Although the Lambda DG-4/5 is simple to use, proper operation depends on the user understanding the design and characteristics of this instrument. This section provides the detailed information needed to begin operation and to control the unit from its keypad.

3.1 Control Electronics

The control electronics for the filter changer are activated by the "MAIN" power switch on the rear of the unit. You may operate the control electronics without the lamp on, but it is best to turn the control electronics off before the lamp is started. Once the lamp has been started (and is ignited), the control electronics may be turned on again.

3.2 Preparation and Precautions

It is assumed that you have now completed attachment of your lamp to a microscope using some combination of filter wheels and a liquid light guide. It is not recommended that you power up the lamp until a solid, leak-free, light path has been established between the lamp cabinet and the microscope. The intensity and wavelengths of the light that can be produced by the Lambda DG-4/5 are such that it should not be turned on unless the light is directed into a microscope and away from the eyes or skin of the operator or other nearby personnel. To reiterate:

WARNING: DO NOT LOOK DIRECTLY INTO THE LIGHT GUIDE! The output of the light or the light guide should be directed into the microscope using the appropriate adapters, directed away from anyone's eyes, and not directed toward any reflective surface.

Due to the current draw during lamp ignition, it is important to power up the Lambda DG-4/5 first before other electronic and computer equipment, especially when they are powered from or grounded to the same circuit. Failure to do so may reset microprocessor-based equipment and/or may destroy sensitive operational amplifier-based instrumentation.

3.3 Power-Up Sequence

There are two switches on the back of the Lambda DG-4/5 labeled LAMP and MAIN. The LAMP switch will ignite and power the xenon lamp. The MAIN switch applies power to the controller and the fan that cools all of the electronics (including the xenon lamp power supply). The MAIN switch should be turned on immediately after the LAMP switch is turned

on and the lamp is ignited. If you are only configuring the Lambda DG-4/5 controller or a computer interface, you do not need to switch on the LAMP before turning on the MAIN switch. The following message will be briefly displayed on the front panel when the MAIN switch is turned on:

```
SUTTER FAST FILTER CONTROLLER PROGRAM
COPYRIGHT SUTTER INSTRUMENT CORP. 2006
```

After a few seconds the MAIN MENU will be displayed:

```
OFF= FILTER NUMBER,  TURBO-BLANKING- OFF
INPUT = MANUAL       MOVE ON COMMAND
```

At this point, the Controller subsystem is ready for operation.

When the unit is first turned on, the **FILTER NUMBER** display will read “OFF”. This indicates that the filter selecting mirrors have been positioned to prevent lamp output from the device. The status of the **TURBO-BLANKING** feature (discussed below) is also shown; OFF is the default setting for that feature when the controller is first powered up.

The second line of the display indicates if the unit is under local control and that the unit will execute all commands as they are received.

The unit selects the PARALLEL MODE as the default remote interface at power on. If the unit is under remote control at power on, the appropriate remote interface mode will be automatically set and the display may change immediately to reflect any waiting computer commands.

3.4 Top Panel Controls

3.4.1 Keypad

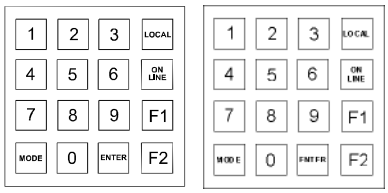


Figure 3-1. Keypad (top panel).

There are 16 keys on the Lambda DG-4/5 keypad. The numerical keys 0 to 9 and six function keys. Keys are read while depressed but the appropriate action will occur only when the key is released. If a key is pressed while a move is in progress but released after the move is over, the key will read normally. Keys pressed and released while a move is in progress are ignored. In the REMOTE MODE only the LOCAL key is active. Holding any other key down while in the REMOTE MODE may cause an interruption in the reading of new commands from the remote computer. The functions of the keys are as follows:

0-9 These keys are used to select modes and make numerical entries while in the various modes of operation. In the MOVE ON COMMAND mode, for example, a FILTER NUMBER may be selected with these keys.

F1, F2 These key are presently used to manually increase or decrease the Output Galvanometer Value (see EDIT A FILTER VALUE DEFINITION).

LOCAL Pressing this key puts the unit under LOCAL control. This is the only key that has an effect when the Lambda DG-4/5 is ON LINE (i.e., under the remote control of an interfaced external source, such as a computer.

ON LINE This key transfers control of the Lambda DG-4/5 to an interfaced external source, such as a computer. This transfer can also be done by sending the correct signal from the external source as outlined under the interfacing section. The default input port is the PARALLEL PORT, so the display will indicate PARALLEL MODE after the ON LINE key has been pressed (unless the SERIAL PORT is active).

ENTER This key is used in conjunction with the numeric keys for selecting FILTER NUMBERS and entering other numeric data. It is also used to exit certain set-up modes when data entry has been completed.

MODE This key is used to locally to set the mode of operation and to access setup modes. This key does not directly relate to the mode of input. Pressing the MODE key will initiate a mode selection routine, which will present a series of linked menus (see the section on "Selecting an Operational Mode").

RESET Pressing the RESET button at any time causes the control unit to start the power-up sequence outlined above. The sequence starts with a delay after the end of the button-press. The display will be cleared until the initialization screen is written.

3.5 Electrical Connections

All Electrical connections are made on the rear panel of the Lambda DG-4/5.

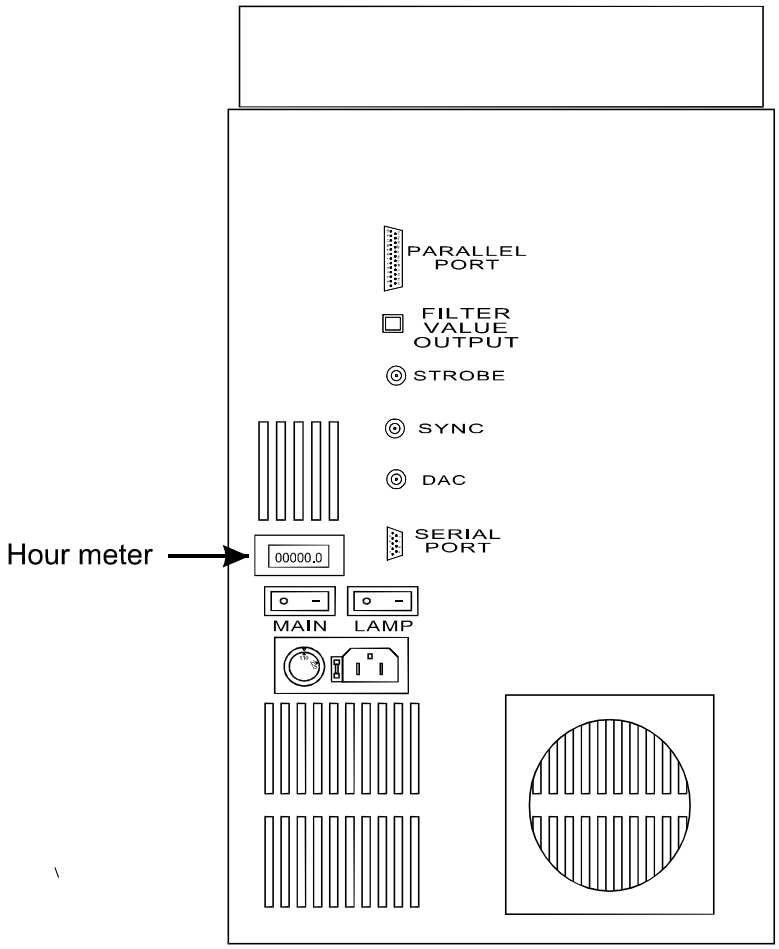


Figure 3-2. Electrical connections (rear panel).

3.5.1 Parallel Port

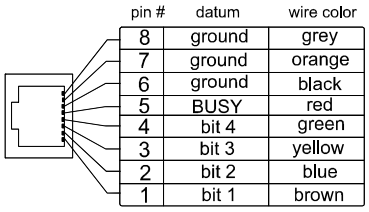
This 25-pin DSUB connector is used for establishing a parallel interface between the Lambda DG-4/5 and a remote device (computer) using the cable provided. This cable should not be used simultaneously with the serial port cable.

3.5.2 Serial Port

This 9-pin DSUB connector is used for establishing a serial interface between the Lambda DG-4/5 and a remote device (computer) using the cable provided. This cable should not be used simultaneously with the parallel port cable.

3.5.3 Filter Value Out

This 8-pin, Modular connector provides a digital indicator of the value of the FILTER NUMBER in use. Pin numbers 1 through 4 correspond to the bit number of the 4-bit binary equivalent of the decimal FILTER NUMBER value. Pin 5 carries the BUSY line signal and pins 6 through 8 are tied to ground.



pin #	datum	wire color
8	ground	grey
7	ground	orange
6	ground	black
5	BUSY	red
4	bit 4	green
3	bit 3	yellow
2	bit 2	blue
1	bit 1	brown

Figure 3-3. Filter value out connector.

3.5.4 Sync

This BNC connector is the video synchronization input. NOTE: THIS INPUT IS NOT INTERNALLY GROUNDED. If the ground in the camera being used is floating, the camera's synchronization signal to the Lambda DG-4/5 SYNC input will cause the galvanometers to oscillate at a high, irregular rate.

3.5.5 DAC

This BNC connector provides an analog indicator of the current FILTER NUMBER:

DAC Output = FILTER NUMBER x 400 mV

3.5.6 Strobe

This BNC connector is the "trigger" input for the MOVE ON TRIGGER mode of operation.

3.5.7 Line Power

This socket is used to connect the power cord provided with the Lambda DG-4/5.

3.6 Fuse

The fuse used in this instrument depends on the power rating of the installed lamp and mains voltage. See APPENDIX C (FUSE REPLACEMENT) for fuse-type details and fuse installation.

3.7 Modes of Operation (LOCAL)

3.7.1 General Information

Filter switch timing can be controlled using one of four different operational modes.

- **MOVE ON COMMAND (default mode)**
- **MOVE ON STROBE PULSE**
- **MOVE ON SYNC PULSE**
- **MOVE ON SYNC PULSE, INHIBITED BY THE STROBE LINE**

The default mode ("MOVE ON COMMAND") allows you to directly command filter changes (e.g., using the numeric keys on the keypad when the Lambda DG-4/5 is under LOCAL ("Manual") control). Filter changes can also be controlled using an external trigger ("MOVE ON STROBE PULSE"), video synchronization pulse ("MOVE ON SYNC PULSE") or a combination of these two external sources ("MOVE ON SYNC PULSE, INHIBITED BY THE STROBE LINE"). By default, the Lambda DG-4/5 will be in the MOVE ON

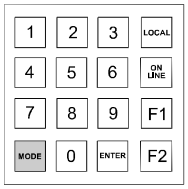
COMMAND mode when it starts up, and at any time after a "triggered" mode has been inactivated. The active operational mode (of these four) will be indicated on the right side of the bottom line in the MAIN MENU.

In addition to the above operational modes that control the timing of the filter changes, there are four others available which alter the Lambda DG-4/5's function:

- **EDIT A FILTER DEFINITION**
- **SETUP THE RING BUFFER**
- **TURBO-BLANKING**
- **DISPLAY THE FIRST 4 FILTER VALUES**

All of the eight operational modes listed above may be accessed from any one of the three sources of control input, LOCAL (keypad), SERIAL PORT, or PARALLEL PORT. Although the details of how an operational mode is selected may vary somewhat from one source of input to another, its function remains the same. In this section, the operational modes will be described in terms of LOCAL control. Separate sections discussing interfacing the Lambda DG-4/5 with remote devices (computers) will cover access to these same modes of operation using SERIAL and. PARALLEL inputs.

3.7.2 Selecting an Operational Mode: The MODE Key



[MODE/1]

When the MAIN MENU is displayed, the **MODE** button on the keypad is used to start a mode selection routine. This routine will present options using a series of linked menus (shown below). Each of the menus will give you the following choices:

- **EXIT the mode selection routine and return to the MAIN MENU (press** 0**)**
- **Go to the NEXT PAGE (press** 1**)**
- **Select an OPERATIONAL MODE from the one or more options presented on the menu (press the numeric key corresponding to the desired mode)**

The series of menus in this routine and their options are as follows:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

Pressing the **0** key will return to the MAIN MENU. Repeatedly pressing **1** for the NEXT PAGE produces the following succession of menus:

```
0=EXIT, 1=NEXT PAGE. 4= MOVE ON SYNC.
PULSE, 5 FOR MOVE ON STROBE PULSE
```

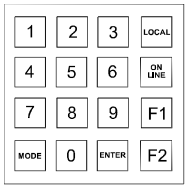
```
0=EXIT, 1=NEXT PAGE. PRESS 6 FOR MOVE ON
SYNC, INHIBITED BY THE STROBE LINE
```

```
0=EXIT, 1=NEXT PAGE. 7 = EDIT A FILTER
DEFINITION, 8 = SETUP THE RING BUFFER
```

Pressing **1** again at this point will not produce further screens.

The above menus are of informational value, only. Once the MODE button has been pressed any one of the seven operational modes presented (# 2 through 8) can be selected by pressing the corresponding numeric key. For example, to set the MOVE ON SYNC PULSE mode, simply press the **MODE** key, followed by the **4** key to directly access that mode's menu.

3.7.3 Move on Command Mode



[1 through 15]

Selecting a new filter: The numeric keys. By default, the Lambda DG-4/5 will be in the MOVE ON COMMAND mode and under LOCAL control ("manual mode") when it starts up, unless remote commands are waiting on an interfaced device connected to an input port. The default FILTER NUMBER will be 0, yielding no light output. Selection of a new FILTER NUMBER is made using the keypad, and will immediately yield light through the FILTER POSITION and at the ATTENUATION level previously programmed for that FILTER NUMBER value (see the section on SETUP modes). Under LOCAL control, the filter is selected by entering a value in the range of 0 to 15. If a single digit value is desired, the user may either press **0** and then the correct numeric key or just the single correct numeric key followed by ENTER. If the value is a 2-digit number, press the correct 2 keys (**1** and then the second key) but do not press **ENTER**. **Pressing ENTER without first pressing a numeric key will select 0**. Consequently, if you press a 2-digit number correctly and then press **ENTER** you will briefly select the filter you desired and then filter 0 (closing the "shutter"). The following examples demonstrate the two methods of entering a single digit FILTER NUMBER (8 in this case).

Method 1: The main menu would look like this if the initial FILTER NUMBER = 10

```
10 = FILTER NUMBER,  TURBO-BLANKING- OFF
INPUT = MANUAL       MOVE ON COMMAND
```

The numeric key **8** is then pressed to call for FILTER NUMBER = 8.

```
80 = FILTER NUMBER,  TURBO-BLANKING- OFF
INPUT = MANUAL       MOVE ON COMMAND
```

When the **ENTER** key is then pressed, FILTER NUMBER 8 is then displayed correctly.

```
 8 = FILTER NUMBER,  TURBO-BLANKING- OFF
INPUT = MANUAL       MOVE ON COMMAND
```

Method 2: The main menu will look like this if the initial FILTER NUMBER = 10

```
10 = FILTER NUMBER,  TURBO-BLANKING- OFF
INPUT = MANUAL       MOVE ON COMMAND
```

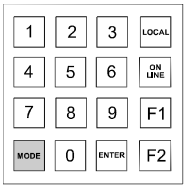
The numeric key **0** is pressed first.

```
00 = FILTER NUMBER,  TURBO-BLANKING- OFF
INPUT = MANUAL       MOVE ON COMMAND
```

The numeric key **8** is pressed next with no further action required. FILTER NUMBER 8 is then displayed correctly.

```
 8 = FILTER NUMBER,  TURBO-BLANKING- OFF
INPUT = MANUAL       MOVE ON COMMAND
```

3.7.4 Move on Sync Pulse Mode



[MODE/4]

If the Move on Sync Pulse Mode is active, the controller will advance to the next filter in a previously programmed FILTER NUMBER sequence (Ring Buffer) when an internal video synchronization (sync) circuit detects the vertical sync pulse of a composite video signal applied to the SYNC input on the rear of the Lambda DG-4/5. In this way, filter changes can be coordinated to occur with the capture of video "frames". The FILTER NUMBER sequence can be programmed at your convenience and then executed later with precise timing (see SET UP THE RING BUFFER). The FILTER NUMBERS can also be sent individually via the serial or parallel port before the trigger event. This operational mode is selected by pressing the MODE key followed by the **4** key to get to the MOVE ON SYNC PULSE menu. Alternatively, you can "page" through the mode selection menus by pressing MODE followed by the 1 key. The following menu will be displayed:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

Press **1** for the NEXT PAGE to see the desired option or press the **0** key to abort the routine and return to the MAIN MENU.

```
0=EXIT, 1=NEXT PAGE. 4= MOVE ON SYNC.
PULSE, 5 FOR MOVE ON STROBE PULSE
```

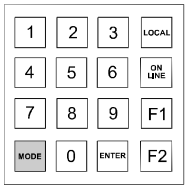
Press **4** to view the MOVE ON SYNC PULSE menu.

```
ADVANCE TO NEXT FILTER ON SYNC IS OFF
PRESS 1 TO TURN ON, 0 TO KEEP IT OFF
```

Press **1** to activate MOVE ON SYNC PULSE and return to the MAIN MENU or press **0** to abort the mode selection routine and retain the current mode setting. The status of the operational mode will be indicated in the lower line of the MAIN MENU display.

```
10 = FILTER NUMBER,  TURBO-BLANKING- OFF
INPUT = MANUAL       MOVE ON SYNC PULSE
```

3.7.5 Move on Strobe Pulse Mode



[MODE/5]

When this mode is active the controller will advance to the next filter in a previously programmed FILTER NUMBER sequence (Ring Buffer) when a logic signal applied to the STROBE input goes from low to high. The FILTER NUMBER sequence can be programmed at your convenience and then executed later with precise timing (see SETUP THE RING BUFFER). The FILTER NUMBERS can also be sent individually via the serial or parallel port before the trigger event. This operational mode is selected by pressing the MODE key followed by the **5** key to get to the MOVE ON STROBE PULSE menu. Alternatively, you can "page" through the mode selection menus by pressing MODE followed by the 1 key. The following menu will be displayed:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

Press **1** for the NEXT PAGE to see the desired option or press the **0** key to abort the routine and return to the MAIN MENU.

```
0=EXIT, 1=NEXT PAGE. 4= MOVE ON SYNC.
PULSE, 5 FOR MOVE ON STROBE PULSE
```

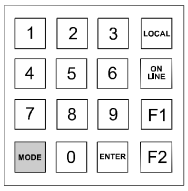
Press **5** to view the MOVE ON STROBE PULSE menu.

```
ADVANCE TO NEXT FILTER ON STROBE IS OFF
PRESS 1 TO TURN ON, 0 TO KEEP IT OFF
```

Press **1** to activate MOVE ON STROBE and return to the MAIN MENU or press **0** to abort the mode selection routine and retain the current mode setting. The status of the operational mode will be indicated in the lower line of the MAIN MENU display.

```
10 = FILTER NUMBER,  TURBO-BLANKING- OFF
INPUT = MANUAL       MOVE ON STROBE PULSE
```

3.7.6 Move on Sync, Inhibited by the Strobe Line Mode



[MODE/6]

This mode combines the functions of the MOVE ON SYNC PULSE and the MOVE ON STROBE PULSE modes (see above) to allow the capture of more than one video frame before advancing to the next filter in the previously programmed series of FILTER NUMBERS (Ring Buffer). In this mode the Lambda DG-4/5 controller will ignore the SYNC input until it detects a state change in the STROBE LINE, from HIGH to LOW. Then it will advance to the next filter in synchrony with the next vertical sync pulse that occurs. The computer interfaced with the Lambda DG-4/5 must be set up to monitor the video signal and hold the STROBE line HIGH if the number of frames to be captured with each FILTER NUMBER is to be constant. This option might also be used to solve some timing problems that can result when using inherently fast software or computers. Selection of this mode is made by pressing the MODE key followed by the **6** key to get to the MOVE ON SYNC, INHIBITED BY THE STROBE LINE menu. Alternatively, you can "page" through the mode selection menus by pressing MODE. The following menus will be displayed:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

Press **1** twice to scroll through the NEXT PAGE to see the desired option or press the **0** key to abort the routine and return to the MAIN MENU.

```
0=EXIT, 1=NEXT PAGE. 4= MOVE ON SYNC.
PULSE, 5 FOR MOVE ON STROBE PULSE
```

```
0=EXIT, 1=NEXT PAGE. PRESS 6 FOR MOVE ON
SYNC, INHIBITED BY THE STROBE LINE
```

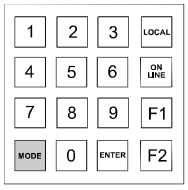
Press **6** to view the MOVE ON SYNC, INHIBITED BY THE STROBE LINE menu.

```
NEXT FILTER ON SYNC, INHIBITED BY STROBE,
IS OFF. PRESS 1 TO TURN ON, 0 TO KEEP IT OFF
```

Press **1** to activate MOVE ON SYNC, INHIBITED BY STROBE and return to the MAIN MENU or press **0** to abort the mode selection routine and retain the current mode setting. The status of the operational mode will be indicated in the lower line of the MAIN MENU display

```
10 = FILTER NUMBER,  TURBO-BLANKING-  OFF
INPUT = MANUAL       MOVE ON SYNC/STROBE
```

3.7.7 Edit a Filter Definition Mode



[MODE/7]

3.7.7.1 General Information

The optical pathway for light from the xenon lamp in the Lambda DG-4/5 is determined by the angle at which the mirrors on the Input and Output galvanometers are positioned. The Input Galvanometer directs the collimated light beam through one of the four FILTER POSITIONS (shown below) and, thus, through whatever interference filter is installed there. The angle of a Galvanometer is not expressed in degrees, here, but in an arbitrary unit whose value ranges from 0 to 4095. The Input Galvanometer Value that defines the optimal light path for each of the FILTER POSITIONS in your Lambda DG-4/5 has been determined at the factory, and is provided on a separate Optical Alignment Data Sheet (see the example shown below).

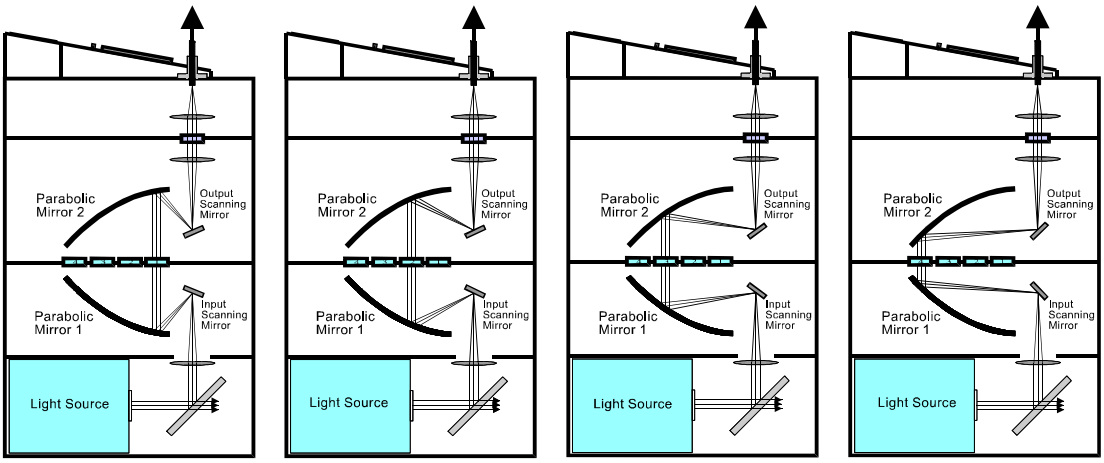


Figure 3-4. Optical pathway based on filter position.

The position of the Output Galvanometer must be coordinated with that of the Input Galvanometer to complete the optical pathway to the Light Guide Port (shown above). The Output Galvanometer angle is also expressed in an arbitrary unit whose value ranges from 0 to 4095. The discrete Output Galvanometer Value that defines the optimal light path for each of the FILTER POSITIONS has been determined at the factory, and can be found on the Optical Alignment Data Sheet. The following table shows some typical Galvanometer Values for each FILTER POSITION.

Table 3-1. Input and output galvanometer values based on filter position.

Filter Position	Input Galvanometer	Output Galvanometer
1	3500	750
2	2500	1500
3	1500	2500
4	750	3500

3.7.7.2 Filter Numbers

The Lambda DG-4/5 uses paired Input and Output Galvanometer Values to define a given optical pathway. Any pair of Galvanometer Values can be assigned a FILTER NUMBER from 1-15. It is important to remember that a FILTER NUMBER is a “logical filter” and does not necessarily correspond to the number on the cabinet that labels the FILTER POSITION through which that optical pathway passes. The Input and Output Galvanometer Values that define the optical pathway that passes through FILTER POSITION number 4 in the sample values shown above would be 1000 and 4000, respectively. Those Galvanometer Values could be assigned any FILTER NUMBER from 1 through 15.

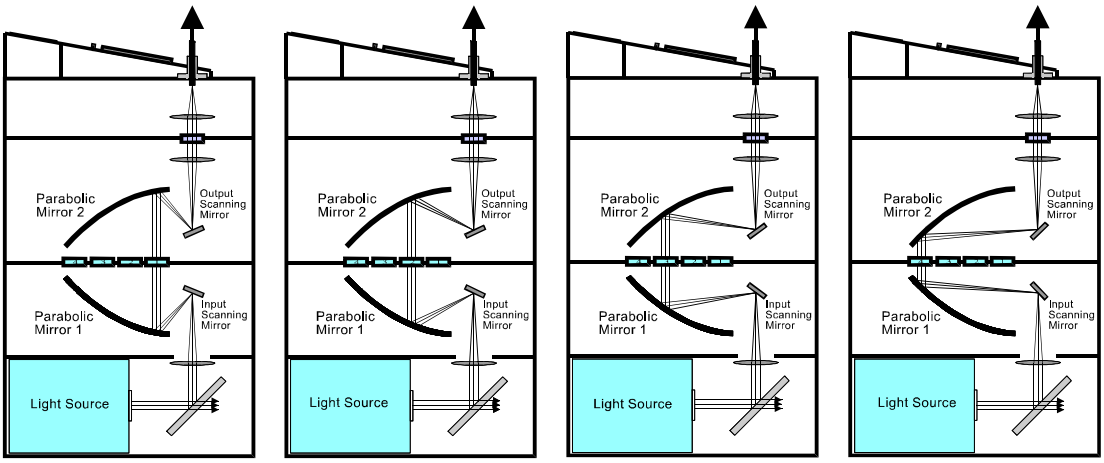


Figure 3-5. DG-4/5 output attenuation.

3.7.7.3 Attenuation

If the Output Galvanometer value is either slightly increased or decreased from the value that produces the peak output, the light coupled into the light guide will decrease as schematically depicted in the figure on the following page. The nominal relationship between galvanometer value and output is shown in the plot below. The exact relationship may vary from unit to unit and filter position to filter position. The actual attenuation produced must be determined by the user. The degree of attenuation produced by increasing the galvanometer value is similar to that produced by an equivalent decrease. Remember, though, that you are limited to an overall range of 0 to 4095. If the output galvanometer value for maximum output is already within 1000 units of a limit (0 or 4095) it is logical to attenuate by changing the value in the direction that moves away from that limit. This method is very useful for attenuating output by less than 1 log unit. It is recommended that you use neutral density filters when attenuation of 1 log unit or more is desired.

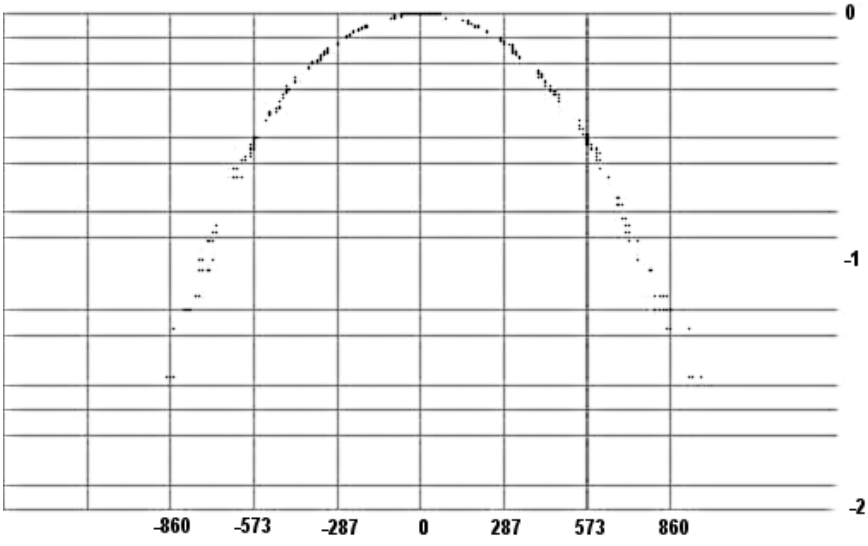


Figure 3-6. Log of attenuation vs. change in output galvanometer value.

3.7.7.4 Programming a Filter Number ("Logical Filter")\

The Galvanometer Values that define the maximal light output through FILTER POSITIONS 1,2,3 and 4 have been assigned FILTER NUMBERS 1,2,3 and 4, respectively, at the factory. It is recommended that these assignments be retained but there is no overwrite protection. If you do edit these values, the original values can be found on the Optical Alignment Data Sheet that came with your Lambda DG-4/5. Galvanometer Values, which maximally misalign the Input and Output Galvanometers, have been assigned FILTER NUMBER 0. When selected, this FILTER NUMBER will prevent light output and serve as a "logical shutter".

The EDIT A FILTER DEFINITION mode is the operational mode from which you assign paired Galvanometer Values a FILTER NUMBER. It is selected by pressing the MODE key followed by the **7** key to get to the EDIT A FILTER DEFINITION menu. Alternatively, you can "page" through the mode selection menus by pressing MODE. The following menu will be displayed:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

Press **1** three times to scroll through the NEXT TWO PAGES to see the desired option or press the 0 key to abort the routine and return to the MAIN MENU.

```
0=EXIT, 1=NEXT PAGE. 4= MOVE ON SYNC.
PULSE, 5 FOR MOVE ON STROBE PULSE
```

```
0=EXIT, 1=NEXT PAGE. PRESS 6 FOR MOVE ON
SYNC, INHIBITED BY THE STROBE LIN
```

```
0=EXIT, 1=NEXT PAGE. 7 = EDIT A FILTER
DEFINITION, 8 = SETUP THE RING BUFFER
```

Press **7** to view the EDIT A FILTER DEFINITION menu.

```
WHICH FILTER DO YOU WISH TO EDIT OR
CREATE?
```

Enter the desired FILTER NUMBER (0-15) as described in the MOVE ON COMMAND section; for one digit values, press the desired numeric key followed by ENTER or press the 0 key then the desired numeric key; for two digit values press the numeric keys only. Pressing the MODE key will abort the EDIT routine, return you to the first MODE SELECTION menu and retain the current FILTER NUMBER settings. If you have entered a FILTER NUMBER value (e.g., 4), the following edit screen will appear:

```
FILTER NO. = 4 , OLD INPUT VALUE =   502
ENTER NEW INPUT GALVO. VALUE
```

At this prompt, enter the desired Input Galvanometer Value. The Lambda DG-4/5 will expect to have four digits entered. If fewer are entered you must complete the entry by pressing the **ENTER** key. If you wish to leave the value unchanged, press **ENTER** without first pressing any numeric keys. In either case next EDIT screen will appear:

```
FILTER NO. = 4 , OLD OUTPUT VALUE = 3919
ENTER NEW OUTPUT GALVO. VALUE
```

At this prompt, enter the desired Output Galvanometer Value. Four digits are expected. If fewer are entered you must complete the entry by pressing the **ENTER** key. If you wish to leave the value unchanged, press **ENTER** without first pressing any numeric keys. Either of these entries will complete the EDIT routine and take you back to the MAIN MENU.

3.7.7.5 Manual Adjustment of Attenuation

There are times when you may wish to increment the level of attenuation up or down to empirically determine the optimal light output for a given application. This could be accomplished by repeatedly reprogramming the FILTER NUMBER you wish to evaluate but that would prove quite tedious. Direct control of the Output Galvanometer Value assigned to any FILTER NUMBER is possible using the FILTER ADJUSTMENT sub-routine, which is part of the EDIT A FILTER NUMBER DEFINITION mode. To access the FILTER ADJUSTMENT menu press the MODE key followed by the **7** key to get to the EDIT A FILTER DEFINITION menu. Alternatively, you can "page" through the mode selection menus by pressing MODE. The following menus will be displayed:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

Press **1** three times to scroll through the NEXT TWO PAGES to see the desired option or press the **0** key to abort the routine and return to the MAIN MENU.

```
0=EXIT, 1=NEXT PAGE. 4= MOVE ON SYNC.
PULSE, 5 FOR MOVE ON STROBE PULSE
```

```
0=EXIT, 1=NEXT PAGE. PRESS 6 FOR MOVE ON
SYNC, INHIBITED BY THE STROBE LINE
```

```
0=EXIT, 1=NEXT PAGE. 7 = EDIT A FILTER
DEFINITION, 8 = SETUP THE RING BUFFER
```

Press **7** to view the EDIT A FILTER DEFINITION menu.

```
WHICH FILTER DO YOU WISH TO EDIT OR
CREATE
```

At this point, enter the number 99 instead of a valid FILTER NUMBER. The following prompt will appear:

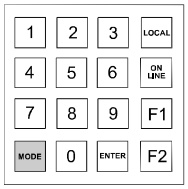
```
WHICH FILTERS OUTPUT DO YOU WANT TO ADJ.
```

Enter the desired FILTER NUMBER (0-15) as described in the MOVE ON COMMAND section; for one digit values, press the desired numeric key followed by ENTER or press the **0** key before the desired numeric key; for two digit values press the numeric keys only. Pressing the **MODE** key will abort the EDIT routine, return you to the first MODE SELECTION menu and retain the current FILTER NUMBER settings. If you have entered a FILTER NUMBER value (e.g., 4), the following edit screen will appear:

```
FILTER NO. 4     CURRENT VALUE =   3919
```

Now press the **F1** key to increase the Output Galvanometer Value or press the **F2** key to decrease the Output Galvanometer Value. These keys can be briefly depressed and released to increment or decrement the value slowly or they can be held down continuously (for more than 2 seconds) to rapidly increase or decrease the value. When you are finished press the **ENTER** key to return to the MAIN MENU.

3.7.8 Setup Ring Buffer Mode



[MODE/8]

3.7.8.1 General Information

The Lambda DG-4/5 controller will accept a sequence of up to 32 FILTER NUMBER values into its non-volatile memory as part of the “RING BUFFER”. This sequence of FILTER NUMBERS can then be “played back” during an experiment. It is possible to program a total of 64 FILTER NUMBER values into the RING BUFFER but the additional 32 values are stored in a volatile memory and will be lost if the Lambda DG-4/5 is turned off or RESET.

The values in the RING BUFFER can be stored and viewed while in any operational mode but it can only be RUN from one of the “triggered” operational modes since the filter changes are dependent on a STROBE PULSE or SYNC PULSE.

NOTES:

1. The RING BUFFER will not run autonomously (i.e., in the MOVE ON COMMAND mode). It must be triggered by a SYNC or STROBE PULSE.
2. The RING BUFFER cannot be appended. When you "record" the sequence it is "all or nothing", over-writing any previously recorded FILTER NUMBERS.

3.7.8.2 Storing the FILTER NUMBER Sequence

The controller will accept a sequence of up to 64 FILTER NUMBERS (only 32 into the non-volatile memory) and store them in a "RING BUFFER". To gain access to the SETUP RING BUFFER menu, press the **MODE** key followed by the **8** key. Alternatively, you can "page" through the mode selection menus by pressing **MODE**. The following menus will be displayed:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

Press **1** three times to scroll through the NEXT TWO PAGES to see the desired option or press the **0** key to abort the routine and return to the MAIN MENU.

```
0=EXIT, 1=NEXT PAGE. 4= MOVE ON SYNC.
PULSE, 5 FOR MOVE ON STROBE PULSE
```

```
0=EXIT, 1=NEXT PAGE. PRESS 6 FOR MOVE ON
SYNC, INHIBITED BY THE STROBE LINE
```

```
0=EXIT, 1=NEXT PAGE. 7 = EDIT A FILTER
DEFINITION, 8 = SETUP THE RING BUFFER
```

Press **8** to view the SETUP RING BUFFER menu or the **0** key to return to the MAIN MENU. The following display will appear if you press **8**:

```
0=EXIT. 1 = RUN EXISTING BUFFER,  2 = TO
CREATE NEW FILTER SEQUENCE.  3 = DISPLAY
```

Press **2** to begin recording a new sequence of FILTER NUMBERS. The following prompt will briefly appear:

```
ENTER THE FILTER NUMBERS.  TWO ENTERS IN
SUCCESSION WILL END THE STRING.
```

The screen will now be blank. Enter each FILTER NUMBER by pressing the appropriate numeric key followed by the **ENTER** key. Your numeric keystrokes will be echoed on the display and the **ENTER** key will place a comma in the string to delimit each FILTER NUMBER value.

```
1,2,3,4,
```

When you have completed entering the desired sequence, press the **ENTER** key a second time to save it to the RING BUFFER and return to the MAIN MENU.

3.7.8.3 Viewing an Existing FILTER NUMBER Sequence

To display the sequence of FILTER NUMBERS that have been stored in the RING BUFFER access the SETUP RING BUFFER menu by pressing the **MODE** key followed by the **8** key. Alternatively, you can "page" through the mode selection menus by pressing **MODE**. The following menus will be displayed:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

Press **1** three times to scroll through the NEXT TWO PAGES to see the desired option or press the **0** key to abort the routine and return to the MAIN MENU.

```
0=EXIT, 1=NEXT PAGE. 4= MOVE ON SYNC.
PULSE, 5 FOR MOVE ON STROBE PULSE
```

```
0=EXIT, 1=NEXT PAGE. PRESS 6 FOR MOVE ON
SYNC, INHIBITED BY THE STROBE LINE
```

```
0=EXIT, 1=NEXT PAGE. 7 = EDIT A FILTER
DEFINITION, 8 = SETUP THE RING BUFFER
```

Press **8** to view the SETUP RING BUFFER menu or the **0** key to return to the MAIN MENU. The following display will appear if you press **8**:

```
0=EXIT. 1 = RUN EXISTING BUFFER,  2 = TO
CREATE NEW FILTER SEQUENCE.  3 = DISPLAY
```

Press **3** to display the existing sequence of FILTER NUMBERS in the RING BUFFER. The first page of RING BUFFER values will be displayed:

```
1,2,3,4,
```

The first page will contain the first 26 values separated by commas. There are three pages available for displaying the RING BUFFER values. To move between the pages press the numeric key (**1**,**2** or **3**) corresponding to the desired page. Press **ENTER** to return to the MAIN MENU.

3.7.8.4 Running the RING BUFFER Sequence

The values in the RING BUFFER can only be RUN from one of the "triggered" operational modes since the filter changes are dependent on a STROBE PULSE or SYNC PULSE. Make certain that you have selected a "triggered" mode before proceeding and that the trigger source is connected to the appropriate input on the back of the Lambda DG-4/5. To "manually" RUN the RING BUFFER access the SETUP RING BUFFER menu by pressing the **MODE** key followed by the **8** key. Alternatively, you can "page" through the mode selection menus by pressing **MODE**. The following menus will be displayed:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

Press 1 three times to scroll through the NEXT TWO PAGES to see the desired option or press the 0 key to abort the routine and return to the MAIN MENU.

```
0=EXIT, 1=NEXT PAGE. 4= MOVE ON SYNC.
PULSE, 5 FOR MOVE ON STROBE PULSE
```

```
0=EXIT, 1=NEXT PAGE. PRESS 6 FOR MOVE ON
SYNC, INHIBITED BY THE STROBE LINE
```

```
0=EXIT, 1=NEXT PAGE. 7 = EDIT A FILTER
DEFINITION, 8 = SETUP THE RING BUFFER
```

Press **8** to view the SETUP RING BUFFER menu or the **0** key to return to the MAIN MENU. The following display will appear if you press **8**:

```
0=EXIT. 1 = RUN EXISTING BUFFER,  2 = TO
CREATE NEW FILTER SEQUENCE.  3 = DISPLAY
```

Press the **1** key to start RUN the RING BUFFER. If you have failed to set a triggered operational mode, you will see the following error message and the RING BUFFER will not RUN.

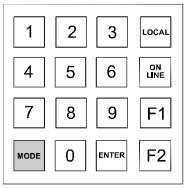
```
ERROR!  A CONTROL MODE MUST BE SELECTED
BEFORE YOU RUN THE RING BUFFER
```

If a "triggered" operational mode has been selected the following status message will be displayed (MOVE ON SYNC, INHIBITED BY STROBE mode is used in this example).

```
FILTER SEQUENCE FROM RING BUFFER
MOVE ON SYNC/STROBE
```

To exit the buffer run, simply hold the LOCAL button down. The controller will not recognize the key press unless it is active just after a filter change has been triggered.

3.7.9 Turbo-Blanking Mode



[MODE/2]

As the optical pathway is transitioning between two FILTER POSITIONS that are not adjacent to one another, the Input Galvanometer must briefly direct the light through any filter(s) intermediate to the desired FILTER POSITION. Under normal operation, the Output Galvanometer moves in phase with the Input Galvanometer and, therefore, maintains the optical pathway to the Light Guide Port as the filter change occurs. This results in a brief output of light at an undesired wavelength prior to arriving at the selected FILTER POSITION. This problem can usually be avoided by placing filters in adjacent FILTER POSITIONS when it is known in advance that you will only want to switch between those two wavelengths. This may not be a practical solution for several situations. The TURBO-BLANKING operational mode eliminates the transmission of undesired wavelengths during filter changes by forcing the Input and Output Galvanometers to move out of phase with one another. In this way, the optical pathway to the Light Guide Port is broken until the Input Galvanometer has arrived at the selected FILTER POSITION and the Output Galvanometer catches up with it. This feature does increase the time required for switching, though. This operational mode is selected by pressing the **MODE** key. The following menu will be displayed:

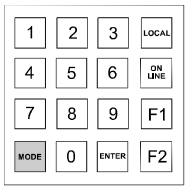
```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

To display the TURBO-BLANKING menu shown below, press **2**.

```
TURBO-BLANKING IS TURNED OFF, PRESS 1 TO
ENABLE OR 0 TO KEEP IT OFF
```

Press **1** to activate the option and return to the MAIN MENU or **0** to abort the routine and return to the MAIN MENU. The status of the TURBO-BLANKING mode will be indicated on the first line of the MAIN MENU.

3.7.10 Display the First Four Filter Values Mode



[MODE/3]

To display the current Input and Output Galvanometer Values for the first four FILTER NUMBERS press the **MODE** key. The following menu will be displayed:

```
0=EXIT, 1=NEXT PAGE, 2 = TURBO BLANKING
3 = DISPLAY THE FIRST 4 FILTER VALUES
```

To bring up the values display, press **3**.

```
#1 IN=3800 OUT=1000  #2 IN=2500 OUT=2100
#3 IN=1500 OUT=3200  #4 IN=1000 OUT=4000
```

Press ANY key to return to the MAIN MENU.

(This page intentionally blank.)

4. EXTERNAL CONTROL OPERATIONS

The Lambda DG-4/5 has both serial and parallel interfaces but these two interfaces should not be connected simultaneously. The parallel port provides you with the fastest remote interface possible. The serial port connection provides you with a similar range of commands but at a significantly slower speed. A serial interface therefore will not fully exploit the Lambda DG-4/5's rapid filter changing capability. Remote control of the Lambda DG-4/5 is similar to that of the Sutter Lambda 10 filter wheel but functional differences in these units require the elimination of some commands and the addition of others. All of the commands are byte (8-bit) values. This corresponds to a single character from the serial port or the value encoded by the eight logic level input lines of the parallel port.

4.1 Parallel Interface

4.1.1 Connecting to the Lambda DG-4/5 parallel port

The parallel interface connector on the back of the cabinet is a DB-25 connector. The connections are arranged so that a standard DB-25 cable can be used to connect the controller to a PC parallel port. This cable should not be used simultaneously with a serial port cable connected to the Lambda DG-4/5.

The pin assignments for this connector are, as viewed from the back of the unit:

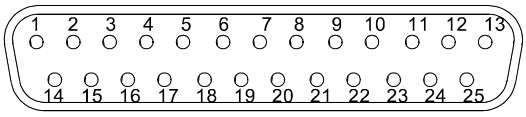


Figure 4-1. Parallel port DB25 connector (male).

Table 4-1. Parallel port pin assignments.

Pin	Function	Pin	Function
1	Not Connected (NC)	14	NC
2	Command Bit 0 (filter)	15	NC
3	Command Bit 1 (filter)	16	NC
4	Command Bit 2 (filter)	17	NC
5	Command Bit 3 (filter)	18	NC
6	Command Bit 4 (hold for trigger)	19	NC
7	Command Bit 5	20	NC
8	Command Bit 6	21	NC
9	Command Bit 7	22	NC
10	NC	23	NC
11	Busy Line Output	24	Ground
12	NC	25	GROUND
13	NC		

4.1.2 Input Lines

The 8 input lines of the parallel input (data input lines 2-9) are read by the controller as an 8 bit value with input line 9 corresponding to the most significant bit. When the control unit is in the ON-LINE (remote) mode, the 8 input lines are examined at 50 microsecond intervals. If the value of the filter or command indicated by the input lines has changed from the previous time the lines were read, the control unit will set the BUSY line and then respond as commanded. See the BUSY LINE section for further details about this data line.

4.1.3 Command Codes

All commands to the Lambda DG-4/5 correspond to an 8-bit binary value (not all of the possible 256 values are utilized). The binary values that are used can be classified in the following way:

Table 4-2. Command code types.

Value range (Decimal, hexadecimal, binary)	Command Type
0 – 15 00 – 0F 00000000 – 00001111	MOVE ON COMMAND to the corresponding FILTER NUMBER (i.e., immediately after receiving the command).
16 – 31 10 – 1F 00010000 – 00011111	MOVE ON TRIGGER to the corresponding FILTER NUMBER (move only if triggered by Strobe, Synch, or Synch gated by Strobe).
32 – 255 20 – FF 00100000 – 11111111	Special commands (22 in all)

The first 16 binary values (00000000-00001111) are read as “filter change” commands that take effect immediately (i.e., “MOVE ON COMMAND”). Each one selects the FILTER NUMBER that corresponds to the command’s decimal value (0 to 15). Another way of stating this is that when the 4 most significant bits of the 8 bit binary value all equal 0 (data input lines 6-9 are all LOW) the 4 least significant bits (data input lines 2-5) will be treated as a four place binary number whose decimal value corresponds to the desired FILTER NUMBER (0-15).

The next 16 binary values (00010000-00011111) are also read as “filter change” commands. These commands will not be executed, however, until the next “trigger” (STROBE or SYNC PULSE, depending on the mode that is active) has been detected. Each of these commands selects the FILTER NUMBER that corresponds to the command’s decimal value less 16. If, for example, you want to select FILTER NUMBER 6 on the next STROBE PULSE, you would send the binary equivalent of the decimal number 22 (00010110). Another way of describing these commands is as follows. When the binary value of the three most-significant bits is 0 (data input lines 9, 8, and 7 are all LOW), and the next least-significant bit’s binary value is 1 (data input line 6 is HIGH), then the four least-significant bits (data input lines 5, 4, 3, and 2) are treated as a 4-bit binary number that corresponds with the desired FILTER NUMBER (0 - 15).

Table 4-3. DG-4-Only filter position movement commands.

Move to Nominal Filter Position	Value (Decimal; hexadecimal; binary)	Move on …	Atte-nuation	Physical Filter Position	Notes
0	0, 00, 00000000	Command	0%	0	Light is blocked (“Shutter Closed”)
1	1; 01; 00000001	Command	100%	1	1st filter (25mm) at full
2	2; 02; 00000010	Command	100%	2	2nd filter (25mm) at full
3	3; 03; 00000011	Command	100%	3	3rd filter (25mm) at full
4	4; 04; 00000100	Command	100%	4	4th filter (25mm) at full
5	5; 05; 00000101	Command	50%	1	1st filter (25mm) at half
6	6; 06; 00000110	Command	50%	2	2nd filter (25mm) at half
7	7; 07; 00000111	Command	50%	3	3rd filter (25mm) at half
8	8; 08; 00001000	Command	50%	4	4th filter (25mm) at half
9	9; 09; 00001001	Command	33%	1	1st filter (25mm) at 1/3
10	10; 0A; 00001010	Command	33%	2	2nd filter (25mm) at 1/3
11	11; 0B; 00001011	Command	33%	3	3rd filter (25mm) at 1/3
12	12; 0C; 00001100	Command	33%	4	4th filter (25mm) at 1/3
13	13; 0D; 00001101				(Unused)
14	14; 0E; 00001110				(Unused)
15	15; 0F; 00001111				(Unused)
16	16; 10; 00010000	Trigger	0%	0	Light is blocked (“Shutter Closed”)
17	17; 11; 00010001	Trigger	100%	1	1st filter (25mm) at full
18	18; 12; 00010010	Trigger	100%	2	2nd filter (25mm) at full
19	19; 13; 00010011	Trigger	100%	3	3rd filter (25mm) at full
20	20; 14; 00010100	Trigger	100%	4	4th filter (25mm) at full
21	21; 15; 00010101	Trigger	50%	1	1st filter (25mm) at half
22	22; 16; 00010110	Trigger	50%	2	2nd filter (25mm) at half
23	23; 17; 00010111	Trigger	50%	3	3rd filter (25mm) at half
24	24; 18; 00011000	Trigger	50%	4	4th filter (25mm) at half
25	25; 19; 00011001	Trigger	33%	1	1st filter (25mm) at 1/3
26	26; 1A; 00011010	Trigger	33%	2	2nd filter (25mm) at 1/3
27	27; 1B; 00011011	Trigger	33%	3	3rd filter (25mm) at 1/3
28	28; 1C; 00011100	Trigger	33%	4	4th filter (25mm) at 1/3
29	29; 1D; 00011101				(Unused)
30	30; 1E; 00011110				(Unused)
31	31; 1F; 00011111				(Unused)

NOTE: “Move on Command” means move the light beam immediately upon receipt of the external command. “Move on Trigger” means move the light beam only until triggered via Strobe, Synch, or Synch gated to Strobe.

Table 4-4. DG-5-Only filter position movement commands.

Move to Nominal Filter Position	Value (Decimal; hexadecimal; binary)	Move on …	Atte-nuation	Physical Filter Position	Notes
0	0, 00, 00000000	Command	0%	0	Light is blocked (“Shutter Closed”)
1	1; 01; 00000001	Command	100%	1	1st filter (18mm) at full
2	2; 02; 00000010	Command	100%	2	2nd filter (18mm) at full
3	3; 03; 00000011	Command	100%	3	3rd filter (18mm) at full
4	4; 04; 00000100	Command	100%	4	4th filter (25mm) at full
5	5; 05; 00000101	Command	100%	5	5th filter (25mm) at full
6	6; 06; 00000110	Command	50%	1	1st filter (18mm) at half
7	7; 07; 00000111	Command	50%	2	2nd filter (18mm) at half
8	8; 08; 00001000	Command	50%	3	3rd filter (18mm) at half
9	9; 09; 00001001	Command	50%	4	4th filter (25mm) at half
10	10; 0A; 00001010	Command	50%	5	5th filter (25mm) at half
11	11; 0B; 00001011	Command	33%	1	1st filter (18mm) at 1/3
12	12; 0C; 00001100	Command	33%	2	2nd filter (18mm) at 1/3
13	13; 0D; 00001101	Command	33%	3	3rd filter (18mm) at 1/3
14	14; 0E; 00001110	Command	33%	4	4th filter (25mm) at 1/3
15	15; 0F; 00001111	Command	33%	5	5th filter (25mm) at 1/3
16	16; 10; 00010000	Trigger	0%	0	Light is blocked (“Shutter Closed”)
17	17; 11; 00010001	Trigger	100%	1	1st filter (18mm) at full
18	18; 12; 00010010	Trigger	100%	2	2nd filter (18mm) at full
19	19; 13; 00010011	Trigger	100%	3	3rd filter (18mm) at full
20	20; 14; 00010100	Trigger	100%	4	4th filter (25mm) at full
21	21; 15; 00010101	Trigger	100%	5	5th filter (25mm) at full
22	22; 16; 00010110	Trigger	50%	1	1st filter (18mm) at half
23	23; 17; 00010111	Trigger	50%	2	2nd filter (18mm) at half
24	24; 18; 00011000	Trigger	50%	3	3rd filter (18mm) at half
25	25; 19; 00011001	Trigger	50%	4	4th filter (25mm) at half
26	26; 1A; 00011010	Trigger	50%	5	5th filter (25mm) at half
27	27; 1B; 00011011	Trigger	33%	1	1st filter (18mm) at 1/3
28	28; 1C; 00011100	Trigger	33%	2	2nd filter (18mm) at 1/3
29	29; 1D; 00011101	Trigger	33%	3	3rd filter (18mm) at 1/3
30	30; 1E; 00011110	Trigger	33%	4	4th filter (25mm) at 1/3
31	31; 1F; 00011111	Trigger	33%	5	5th filter (25mm) at 1/3

NOTE: “Move on Command” means the light beam is moved to the specified position immediately upon receipt of the external command. “Move on Trigger” means move the light beam only until triggered via Strobe, Synch, or Synch gated to Strobe.

Twenty-two of the remaining 224 binary values are used to send commands to the Lambda DG-4/5. These commands are listed in the table on the following page with their corresponding Input Values and descriptions of their functions.

Table 4-5. Controller commands.

Command	Value (Decimal; hexadecimal; binary)	Description
Open Shutter	170 AA 10101010	Moves the light path away from Filter 0 (where the light is blocked) to the filter position at which the light path was positioned prior to issuing the Close Shutter (172) command.
Execute Next Instance of Previous Command	171 AB 10101011	Dummy command that is sent in between any two instances of the "Increment Galvo DAC value for Neutral Density" (235) command or the "Decrement Galvo DAC value for Neutral Density" (236) command.
Close Shutter	172 AC 10101100	Moves the light path from the current filter position to Filter 0, where the light is blocked. The original filter position is stored so that when the Open Shutter (170) command is issued, the light path is moved from Filter 0 back to the original position.
Activate Turbo-Blanking	186 BA 10111010	Turns Turbo-Blanking ON
Deactivate Turbo-Blanking	188 BC 10111100	Turns Turbo-Blanking OFF.
Triggered by Strobe	202 CA 11001010	Selects triggered by strobe line as the ring buffer mode
Disable Strobe Trigger	203 CB 11001011	Deselects triggered by strobe line
Triggered by Video Sync	204 CC 11001100	Selects triggered by video synch as the ring buffer mode
Disable Triggered by Video Sync	205 CD 11001101	Deselects triggered by video sync
Triggered by Video Sync Gated by Strobe	206 CE 11001110	Selects triggered by video sync gated by strobe line as the ring buffer mode
Disable Triggered by Video Sync Gated by Strobe	207 CF 11001111	Deselects triggered by video sync gated by strobe line as the ring buffer mode
Freeze Display	218 DA 11011010	Stops up-dating of the display in order to allow the highest frequency of filter changes
Turn Display ON	219 DB 11011011	Restores normal updating of the display (the opposite of the Freeze Display (218) command).

Command	Value (Decimal; hexadecimal; binary)	Description
Start Loading Ring Buffer	223 DF 11011111	Places the controller in a mode that allows a series of filter values to be loaded in the ring buffer
Start Change of Neutral Density Setting	234 EA 11101010	Places the controller in the N.D. adjust mode. In this mode, the output galvo position for the selected filter value can be changed as a fine adjustment for output intensity.
Increase Value of Galvo DAC for Neutral Density	235 EB 11101011	Increases the galvo DAC value by 1 unit
Decrease Value of Galvo DAC for Neutral Density	236 EC 11101100	Decreases the galvo DAC value by 1 unit
End Change of Neutral Density Setting and Save	237 ED 11101101	Saves the new galvo DAC value and returns to the normal on-line mode
Go On Line (Transfer Control to Computer)	238 EE 11101110	When the control unit is in the local mode, the unit will be forced to go on-line if this code is sent. The input from which this command is received will be the active input and will be identified on the front-panel display. Sending this command via one input when the other input is active will cause the unit to select the input from which the command was received. *If 238 is the current command of the either input, do not send 238 by the other channel and do not attempt to go to the local mode!* In either case, the controller will loop between modes continuously.
End Loading Ring Buffer	240 F0 11110000	Sent after the final value to be loaded in the ring buffer. This saves the new ring buffer values and returns to the normal on-line mode.
Run from Ring Buffer	241 F1 11110001	When this command has been sent, the filter value will be controlled by the ring buffer. The controller will step through the ring buffer, advancing to the next filter for each trigger or sync pulse. One of the three modes of triggering must be selected first.
End Run from Ring Buffer	242 F2 11110010	Returns to normal on-line mode

4.1.4 Busy Line

The Lambda DG-4/5 parallel interface has only one output line, BUSY. The first response of the unit to a new command is to set the BUSY output line HIGH. The BUSY line will stay HIGH until the control unit is ready to accept new data..

The status of the 8 input lines is not checked while the BUSY line is HIGH! There is a short period (as much as 50 microseconds) between when the control unit detects a new value and

the BUSY line is set HIGH. Thus, checking the status of the BUSY line within about 100 microseconds of changing the input lines may give a misleading result.

4.1.5 Interface Modes

Using Input Lines Only: The BUSY line used in the Lambda DG-4/5 was originally implemented in an earlier version of the software that was written for the Lambda-10, a much slower filter-switching device. Because of the DG-4/5's superior filter switching speed, it is not always necessary to attend the state of the BUSY line. In many experimental applications, the Lambda DG-4/5 could be controlled entirely by using only the eight data input lines. The extreme example of this approach would occur when all that is needed in your application is to toggle between two FILTER NUMBERS. In this case, you could select between FILTER NUMBERS 1 and 3 by holding the least significant bit value (data input line 2) HIGH while toggling the next least significant bit value (data input line 3) LOW and HIGH. The remaining data input lines (4-9) could simply be grounded to hold those bit values LOW.

Using Input Lines with the BUSY Line: The conditions that cause the BUSY line to be asserted are noted in the previous paragraph. Reading the status of the BUSY line allows the host computer to determine if the unit is ready to receive a command. A command sent while the BUSY line is HIGH will not be executed until the BUSY line goes LOW. It is possible, then, when using high performance software and hardware that the first of two commands sent in succession could be "lost". Monitoring the state of the BUSY line (Pin 8) can avoid such losses and make time-consuming "time-outs" in the software unnecessary.

4.1.6 Controlling the Lambda DG-4/5 from a Computer's Parallel (Printer) Port

The standard PC parallel port provided for printer control may be used to control the Lambda DG-4/5. This, however, does not mean that instructions can be sent to the Lambda DG-4/5 in the same manner that they are sent to a printer. A printer is designed to print at its maximum rate, and if the computer generates output at a higher rate, the printer will store the output in a buffer until the mechanism is ready. If the buffer becomes full, the printer will indicate to the computer that it is not ready to accept more data. It follows that there is not a tight time relationship between the output of a command from the computer and the execution of that command by the printer.

The time relationship between output of data from the computer and response by the Lambda DG-4/5, in contrast, must be very tight. Thus, it is understandable that the mode of use of the parallel port will be somewhat different for a printer and the Lambda DG-4/5.

The details of the input and output signals were described previously. Now we will discuss the way in which these signals may be used to control the Lambda DG-4/5 from a PC compatible computer's parallel port. This information is provided as a limited example and is only intended to show the elements useful in controlling the Lambda DG-4/5. The user's individual requirements, hardware, and software will dictate the actual program steps to be used. The approach in this example does involve direct control over the state of input and output ports. The example programs have been run successfully on computers from several manufacturers without encountering any difficulties. However, given the wide range of hardware and software in use, it is impossible to anticipate all possible problems. Sutter Instrument Company thus cannot be responsible for any damages that might result from use of the example programs. The user should be particularly careful that the address used for each of the various I/O ports is correct for the user's system.

The parallel (printer) port is actually composed of three I/O ports at three consecutive addresses. The first address corresponds to an 8 bit output port, the second to a 4 bit input port, and the third to a 5 bit input/output port. The first two ports are used in our example. The address of the first (output) port, which is the base address, should be one of three possible values, depending on the individual system.

If the printer adapter is located on a display adapter, it will be called LPT 1 and will have a base address of 956 (3BC H). If there is no active printer adapter on a display adapter card, the primary printer adapter card will be called LPT1 and will have a base address of 888 (378 H). A second printer adapter card in the same system will be called LPT2 and will have a base address of 632 (278 H). Check the documentation of your system and the jumpers on the various adapter cards to be sure of the base address on the adapter you wish to use.

The connections to the parallel port are made through a DB 25 connector on your computer. The pin assignments for the computer parallel port connector are, as viewed from the plug side:

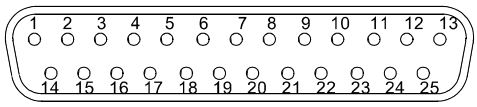


Figure 4-2. DB25 Parallel connector.

Table 4-6. Parallel port pin connections and definitions.

REMOTE PC PARALLEL PORT		LAMBDA DG-4 CONTROLLER	
Pin #	**Pin Description**	**Pin #**	**Pin Description**
1	STROBE	**1**	NC (Not Connected)
2	Data Bit 0	**2**	Filter or Command Bit 0
3	Data Bit 1	**3**	Filter or Command Bit 1
4	Data Bit 2	**4**	Filter or Command Bit 2
5	Data Bit 3	**5**	Filter or Command Bit 3
6	Data Bit 4	**6**	Command Bit 4
7	Data Bit 5	**7**	Command Bit 5
8	Data Bit 6	**8**	Command Bit 6
9	Data Bit 7	**9**	Command Bit 7
10	ACK	**10**	NC
11	BUSY	**11**	BUSY LINE OUTPUT
12	PE	**12**	NC
13	SELECT	**13**	NC
14	AUTOFEED	**14**	NC
15	ERROR	**15**	NC
16	INIT	**16**	NC
17	SELECT IN	**17**	NC
18	GROUND	**18**	NC
19	GROUND	**19**	NC

REMOTE PC PARALLEL PORT		LAMBDA DG-4 CONTROLLER	
Pin #	**Pin Description**	**Pin #**	**Pin Description**
20	GROUND	**20**	NC
21	GROUND	**21**	NC
22	GROUND	**22**	NC
23	GROUND	**23**	NC
24	GROUND	**24**	GROUND
25	GROUND	**25**	GROUND

Commands may be sent through the printer adapter by using an OUT command from basic, or an equivalent command from another language. In Microsoft QuickBasic the form of the command is:

OUT port, data

Where the decimal value of port would be 956, 888, or 632 depending on your system, and data would be a number indicating the desired command.

The number to use for data either will be one of the FILTER NUMBERS or will correspond to one of the commands in the table presented earlier in this section. Thus, to command a move to FILTER NUMBER 4 using a printer adapter having a base address of 888, you would use the following command:

```
OUT 888, 4
```

4.1.7 Reading the Status of the Lambda DG-4/5

The BUSY line is the only output from the Lambda DG-4/5. In the BUSY line section (above), there is a discussion of some of the factors to consider in deciding whether to read the BUSY signal at all. If you have determined that your application requires this output to be read from your computer, this can be done through the 4-bit input port on the printer adapter. The address of this port will be the base address of the printer adapter plus one.

Table 4-7. Parallel port numbering and addressing.

PORT NUMBER AND LOCATION	ADDRESS	
	BASE	**INPUT PORT**
LPT1 on Graphics Adapter	956 (3BC HEX)	957 (3BD HEX)
LPT1 on Printer Adapter	888 (378 HEX)	889 (379 HEX)
LPT2 on Printer Adapter	632 (278 HEX)	633 (279 HEX)

The 4-bit input port uses only the four most significant bits at that address: bits 4, 5, 6 and 7. Bits 0, 1, 2 and 3 are not used by the printer adapter and will normally read as 1. Bit 7 in this input port is normally used by the printer to signal that it is “busy”. That bit is set by the data signal from the printer to Pin 11 of the DB-25 parallel port connector on the back of the computer. The Lambda DG-4/5 uses this same bit in the computer’s printer adapter to indicate that it is BUSY, although the polarity of this signal may differ from the corresponding printer BUSY signal.

With the Lambda DG-4/5 BUSY line connected to PIN 11 of the computer's parallel printer port the input port can be read to obtain the status of the Lambda DG-4/5. Using Microsoft QuickBasic, this would be done as follows:

Listing 4-1. A routine for obtaining the status of the DG-4/5.

```
BUSY:     OUT BASEPORT+2, 16  ' required on some computers
                              ' before data can be read
          FOR U = 0 TO 5          'Delay to allow Lambda DG-4
          NEXT U                  'to set busy flag
LOOK:     STATUS = INP(INPORT)    'Read in from printer port
          STATUS = STATUS AND 128 'Mask to read only bit 7
          IF STATUS <> 128 THEN GOTO LOOK     'Still Busy so loop
          RETURN      'Not Busy so return
```

The example given will loop until the BUSY signal is low. When developing a program it is advisable to insert an escape device in this loop such as:

```
IF INKEY$<>"" THEN RETURN
```

If you are stuck in a tight, endless loop without an escape device, you will have to reset the computer. This statement may be removed once the program is operating correctly.

An alternative command to use in Microsoft QuickBasic is WAIT. This statement has the form:

WAIT *port*, AND*data*, XOR*data*

Where the port is the address of the input port, and data is an integer in the range 0 to 255. When the WAIT statement executes, program execution halts until the input port indicated by port reads as the indicated by data expressions. The AND*data* expression is evaluated as an AND operation. Thus, we may test to see if the BUSY line is set as follows:

```
WAIT 889, 128
```

The program will suspend operation until the value read for the most significant bit is 1. Since the printer adapter inverts this bit, this condition will be met only when the BUSY line is low. An XOR operation can be used as well, as noted in the Microsoft QuickBasic Language Reference. The WAIT statement will XOR the read data before the AND operation if a value for XOR*data* is provided. Consider the statement:

```
WAIT 889, 128, 128
```

The XOR of the read value of the port with 128 will invert the most significant bit. The program execution would thus be suspended until the BUSY signal went high, indicating that the unit was busy. Using the 2 statements in series would insure that the control unit had time to assert the BUSY line in response to a command before the program began to test to see if the BUSY line had come back down:

```
WAIT 889, 128, 128
WAIT 889, 128,
```

THERE IS AN IMPORTANT CONSIDERATION WHEN USING THE WAIT STATEMENT! The WAIT statement seems to be ideal because it provides a fast and easy way of directly testing input port bits. However, if the input port does not have the correct value, and you are unable to force the port to the correct value, you will need to reboot the

computer. This should not be a significant problem in routine operation of a system, but it can provide considerable frustration when developing and testing the control program. Test the WAIT function with simple programs before you use it. Make sure that you will not lose important data if you are forced to reboot.

4.1.8 Shutter Control

The "shutter" is treated as a special FILTER POSITION whose Galvanometer values are assigned to FILTER NUMBER 0. These values set the Galvanometers so that the light path is interrupted, and, therefore act as a shutter when the FILTER NUMBER 0 is selected. The shutter is effectively opened by selecting the desired FILTER NUMBER. If, however, in writing a routine to control the DG-4/5 you wish to return to the last FILTER NUMBER used but do not want to keep track of that value in your program, shuttering can be done using the CLOSE SHUTTER and OPEN SHUTTER commands. OPEN SHUTTER will automatically return the Galvanometers to whatever FILTER NUMBER was last selected before being closed by the CLOSE SHUTTER command. The mechanical effect is the same as selecting FILTER NUMBER 0 to close the shutter followed by the desired FILTER NUMBER to open the shutter.

Table 4-8. Shutter open and close commands.

Command	**Value** (Decimal, hexadecimal, binary)	**Description**
Open Shutter	170 AA 10101010	Moves the light path away from Filter 0 (where the light is blocked) to the filter position at which the light path was positioned prior to issuing the Close Shutter (172) command.
Close Shutter	172 AC 10101100	Moves the light path from the current filter position to Filter 0, where the light is blocked. The original filter position is stored so that when the Open Shutter (170) command is issued, the light path is moved from Filter 0 back to the original position.

4.2 Serial Interface

4.2.1 Connecting to the Lambda DG-4/5 Serial Input

RS-232 serial control of the Lambda DG-4/5 is provided through a 9-pin connector on the rear of the controller cabinet. Only the ground and the two data lines are connected: the hardware control lines are not connected. This cable should not be used simultaneously with a parallel port cable connected to the DG-4/5.

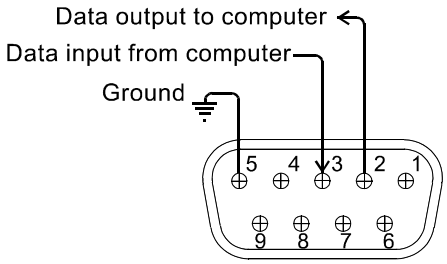


Figure 4-3. Serial control connections (viewed from rear of cabinet).

Communication for the serial port requires the following settings:

- **Data Rate:** **9600 bps (bits per second) or "baud"**
- **Data Bits:** 8
- **Parity:** **None**
- **Stop Bits:** 1
- **Flow Control:** **None**

No hardware control lines are connected. The communication mode must be set so that either these lines are ignored, or connections to these lines are made that satisfy the communications mode desired. In Microsoft Quick Basic, the communication channel may be opened with a statement such as:

```
OPEN "COM1:9600,N,8,1, CD0,CS0,DS0 " FOR RANDOM AS #1 LEN = 256
```

This sets COM1 to the correct mode for bi-directional communication through channel #1. The option list "CD0,CS0,DS0" causes Basic to ignore the DCD, CTS and DSR control lines.

In order to send commands to the Lambda DG-4/5 via the serial port, you must first place the Lambda DG-4/5 in the serial mode. If the Lambda DG-4/5 is in either the parallel or manual mode it can be placed in the serial mode by simply sending the decimal value 238 (EE hexadecimal) via the serial port. Do not send this data value by both the serial and parallel port, since this will cause the controller to rapidly switch between modes. If you send 238 via the serial port, it will be retained as the serial input until another serial command is received. Thus, if you send it via the serial port and do not send another character, neither the manual nor parallel modes can be selected for proper operation.

The mode is indicated on the front panel display. The display will indicate either PARALLEL, MANUAL OR SERIAL. The unit automatically selects the parallel mode at power on. When the value of 238 is received, the display will switch to indicate SERIAL. If any communication errors occur, they will be indicated by the * symbol following the word SERIAL. If the 238 command is not received correctly because of communication errors, the * symbol may replace letters in the word PARALLEL.

4.2.2 Controlling the Lambda DG-4/5 from a Computer's Serial Port

Each 8-bit command listed under the parallel port instructions can also be sent through the serial port. Since the serial data format used is 8 bit, each character sent is a command. If

you have used a BASIC language open statement to establish serial communications, the subsequent 8 bit command values may be sent using a BASIC PRINT # command such as:

```
PRINT #1, CHR$(DATANUM);
```

… where #1 is the file number used in the open statement, and DATANUM is the value of the command to be sent. Note that the CHR$ function allows the actual number to be sent rather than the ASCII numbers of the characters that represent the number. Sending ";" disables the automatic addition of characters such as a linefeed or a space.

For most commands sent over the serial interface, a simple form of protocol is provided that can be used to determine the success or failure of commands and the speed at which commands are transmitted.

In order to read the responses using BASIC, you can use a statement such as:

```
IF LOC(1) > 0 THEN SerialInput$ = INPUT$(1, #1)
```

LOC(1) > 0 indicates that bytes are waiting in the received data buffer. INPUT$(1, #1) reads one byte from the buffer, which is stored as SerialInput$.

4.2.3 Serial Port Command Echo

In the serial mode, the Lambda DG-4/5 controller responds to each command by echoing the command back to the host computer. This indicates that the command was received and will be executed promptly. If the sent command is the same as the last command received, it will not be echoed and the controller will take no action. The following subroutine could be used to hold the computer in a loop until the command is properly echoed.

Listing 4-2. Command echo check routine.

```
COMMANDCHECK: IF LOC(1) > 0 THEN SerialInput$ = INPUT$(1, #1)
                IF DATANUM = ASC(SerialInput$) THEN RETURN
                GOTO COMMANDCHECK
```

NOTE: The only serial command not echoed back by the Lambda DG-4/5 is the "Go On Line" (238 decimal, EE hexadecimal) command.

4.2.4 Serial Port Command Completion Indicator

In the case of filter movement commands (0 through 32), the Lambda DG-4/5 will send back to the host computer a byte with the value of 13 decimal (0D hexadecimal), which is an ASCII CR (carriage return). Nearly the same subroutine can be used to hold the computer in a loop until the carriage return (13) is received.

Listing 4-3. Command-completion check routine.

```
BUSYCHECK:    IF LOC(1) > 0 THEN SerialInput$ = INPUT$(1, #1)
              IF  ASC(SerialInput$)=13 THEN RETURN
              GOTO BUSYCHECK
```

4.2.5 Reading the Status of the Lambda DG-4/5

The Lambda DG-4/5 controller signals that it has completed commands received through its serial port by sending a carriage return back. The following is an example of a QuickBasic

routine that could be used to monitor the status of the DG-4/5 (the example assumes that #1 has already been opened as the serial port to which the DG-4/5 is connected.

Listing 4-4. Reading the Lambda DG-4/5's status.

```
SENDITS:  GOSUB SERCLEAR      'clears receive buffer
          IF DATANUM < 255 THEN PRINT #1, CHR$(DATANUM);  'sends
                                                          'command
          GOSUB SERIN
          DTIME = 10
          RETURN
SERIN:    D = 0   'Check the SERIAL PORT If characters are waiting
SERIN1:   SerialInput$ = ""   'blanks the input variable
          IF LOC(1) > 0 THEN SerialInput$ = INPUT$(1, #1)
          ' if a character is waiting, transfers it to input
          ' variable
          IF SerialInput$ <> "" THEN
              IF DATANUM = ASC(SerialInput$) THEN
                  IF R = 1 THEN RETURN
          ' presets R (="return on echo" switch) to 1 if the last
          ' command did not require a carriage return
          ' character return=13 ends routine (DG-4 is ready)

          IF SerialInput$ = CHR$(13) THEN RETURN
          IF DATANUM = 238 THEN RETURN
          D = D + 1
          IF D > 10000 THEN RETURN
          GOTO SERIN1

SERCLEAR:
          DO WHILE LOC(1) > 0
          SerialInput$ = INPUT$(1, #1)    ' characters waiting
          LOOP
          RETURN
```

Commands

```
DATANUM = 170 'OPEN SHUTTER
DATANUM = 171 'MARKER BETWEEN 235 OR 236 IN N.D. ADJUST
DATANUM = 172 'CLOSE SHUTTER
DATANUM = 186 'ENABLE TURBO BLANKING
DATANUM = 188 'DISABLE TURBO BLANKING
DATANUM = 202 'TRIGGERED BY STROBE
DATANUM = 203 'DISABLE TRIGGERED BY STROBE
DATANUM = 204 'SELECT VIDEO SYNC
DATANUM = 205 'DISABLE VIDEO SYNC
DATANUM = 206 'SELECT VIDEO SYNC GATED BY STROBE LOW
DATANUM = 207 'DISABLE VIDEO SYNC GATED BY STROBE LOW
DATANUM = 218 'FREEZE DISPLAY
DATANUM = 219 'TURN DISPLAY ON
DATANUM = 223 'START LOADING RING BUFFER (UP TO 256 VALUES)
DATANUM = 234 'START REMOTE CHANGE OF N.D. FILTER SETTING
DATANUM = 235 'INCREASE THE DAC GALVO VALUE-SEND 171 AS SPACE
DATANUM = 236 'DECREASE THE DAC GALVO VALUE-SEND 171 AS SPACE
DATANUM = 237 'END CHANGE OF N.D. FILTER SETTING AND SAVE
DATANUM = 238 'FORCE ON-LINE FOR CHANNEL THAT RECEIVED IT
DATANUM = 240 'END LOADING RING BUFFER FILTERS
DATANUM = 241 'RUN RING BUFFER (FIRST SELECT TRIGGER SOURCE)
DATANUM = 242 'END RING BUFFER RUN
```

5. MAINTENANCE

5.1 Changing the Xenon Arc Bulb

5.1.1 Bulb Assembly

The bulb assembly has the following components:

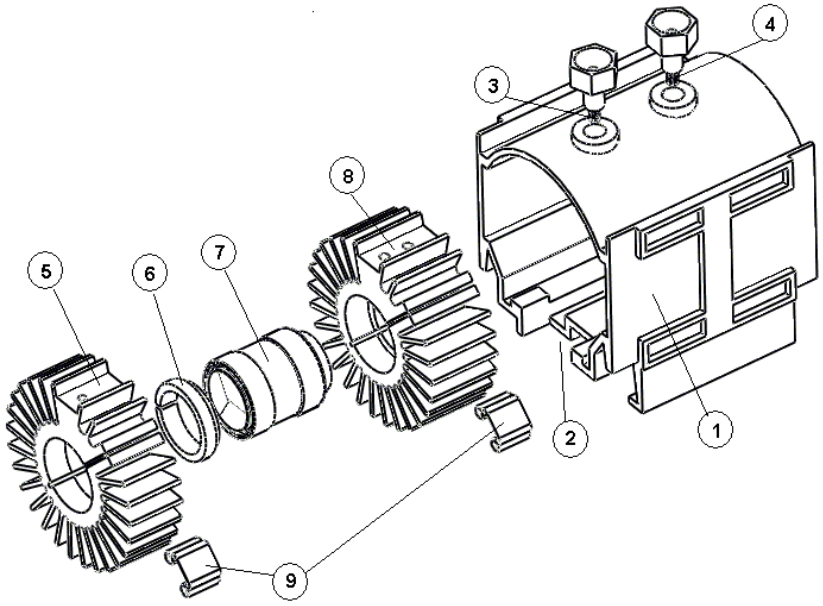


Figure 5-1. Lamp bulb assembly components.

1. Blue lamp housing
2. Notch indicating the front (light output) side
3. Front terminal (smaller threads)
4. Rear terminal (larger threads)
5. Front (thinner) heat sink
6. Bulb mounting ring
7. Xenon Bulb
8. Rear (thicker) heat sink
9. Heat sink retaining clips

5.1.2 Removing the Lamp Assembly from the System

WARNING: Before removing the the lamp assembly from the system, turn off the LAMP and POWER switches, disconnect the power cord from the source, and wait for a couple of minutes for the power supply electronics to discharge. Allow the bulb to cool for at least half an hour before proceeding further.

1. Remove the five screws at the lower left corner of the left side panel (indicated by the arrows in Figure 5-2) and remove the lamp access door. This will expose a black cover panel with four knurled screws.
2. Unscrew the four knurled screws and remove the black cover panel. This will expose the blue plastic lamp housing assembly.
3. Grasp the top and bottom handles of the blue plastic housing assembly and, carefully, pull the assembly straight out of the cabinet.

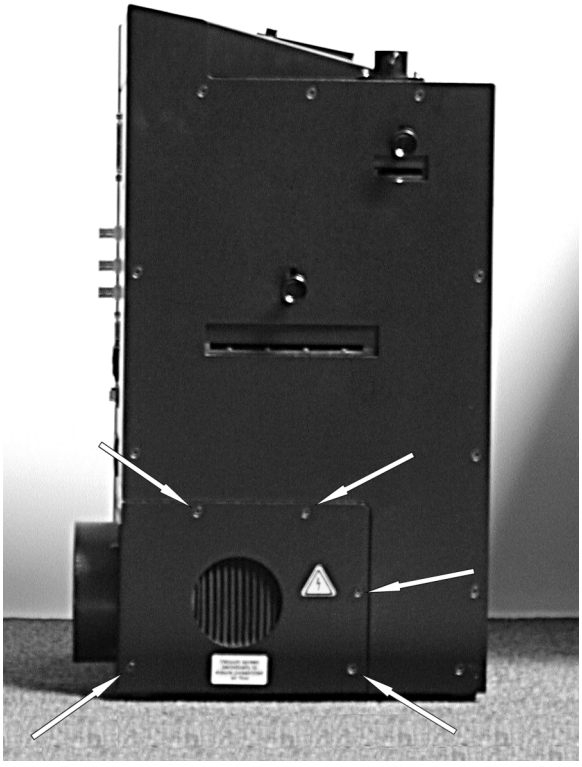


Figure 5-2. Lamp cover panel on left side of the Lambda DG-4/5-series cabinet.

5.1.3 Bulb Replacement

5.1.3.1 Removing the Existing Bulb

1. Remove both terminals (see Figure 5-1) from the blue housing.
2. Slide the bulb/heat sink assembly out from the blue housing.
3. Pry one of the retaining clips off one of the heat sinks and remove the heat sink. If the heat sink does not come off the bulb, insert a flat screw drive in the side slit of the heat sink and widen the gap (Figure 5-3) to remove the bulb. Repeat with the second heat sink.

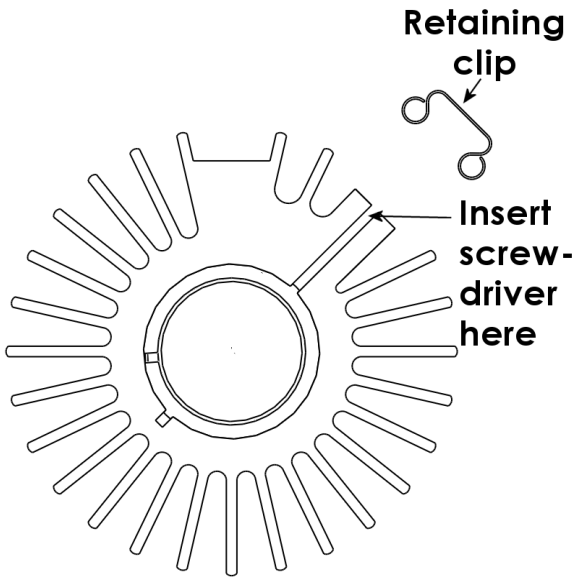


Figure 5-3. Heat sink retaining-clip removal.

4. Wipe off the white thermal compound from inside the heat sinks.
5. The mounting ring (see Figure 5-1) might still be inside the front heat sink. Remove it and set it aside. You will need it if the new bulb does not have one.

5.1.3.2 Installing the New Bulb

1. Without removing the protective cap from the new bulb, apply a thin, even layer of thermal compound to the side surfaces of the anode shell as shown in Figure 5-4.

   ⚠ ***CAUTION: Avoid touching the sapphire window. If heat transfer compound is smeared on the window, it can be removed by gently wiping it off with a dry, lint-free tissue (lens paper or lens cloth).***

2. Slide the rear heat sink on the anode shell and press on or lightly tap the retaining clip, positioning it flush with the inside edge of the heat sink.

   ⚠ ***CAUTION: Once the retaining clips are in place, the heat sinks should be tight enough not to slide around the bulb. If they still slide, remove the retaining rings, tighten them using a vice or adjustable pliers, and then reaffix them on to the heat sinks.***

3. Remove the protective cap from the new bulb. If there is no mounting ring attached, use the ring from the old bulb. Apply a thin, even layer of thermal compound on the cathode shell on the surface shown in Figure 5-4. Slide on the front heat sink, align it with the rear heat sink (Figure 5-5) and press on the retaining clip positioning it flush with the inside edge of the heat sink.

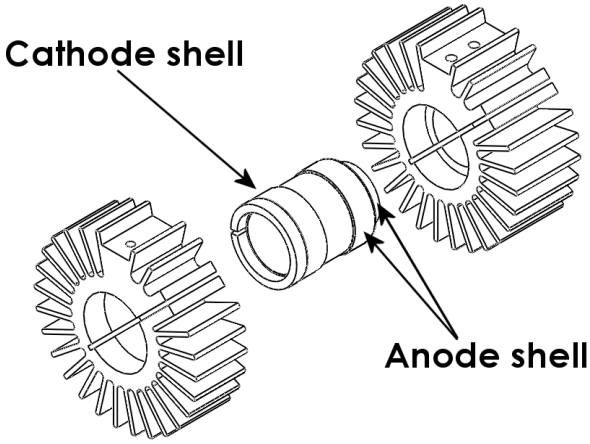


Figure 5-4. Bulb surfaces requiring they be covered with thermal compound.

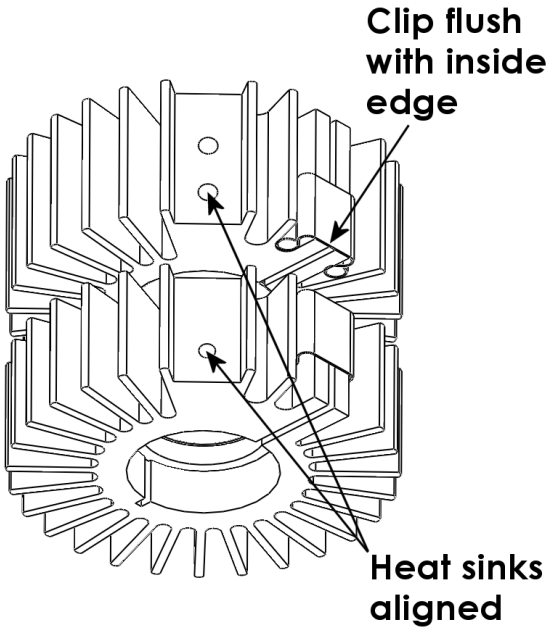


Figure 5-5. Heat sink alignment and positioning of the retaining clips.

4. Insert the heat sink/bulb assembly into the blue housing. Make sure the SAPPHIRE WINDOW side (output) is the same side as the notch in the blue housing (Figure 5-6). Screw in the terminals (the one located closer to the sapphire window has smaller threads than the other) slightly more than hand tight to complete the bulb installation in the blue housing.

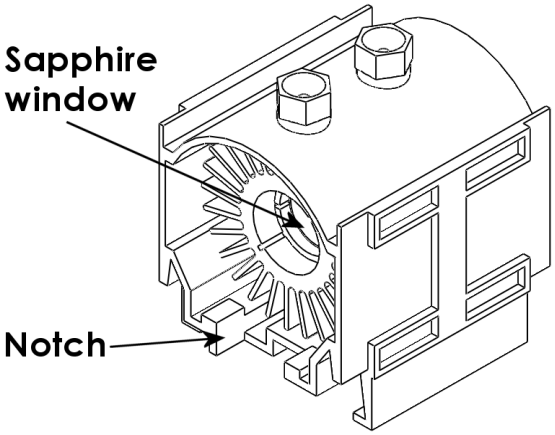


Figure 5-6. Position of the bulb/heat sink assembly in the blue housing.

5.1.4 Reinstalling the Lamp/Housing Assembly to the System

1. Grasp the top and bottom handles of the blue plastic housing assembly and carefully reinsert the assembly into the cabinet (Figure 5-7) with the bulb window facing away from the lamp fan.

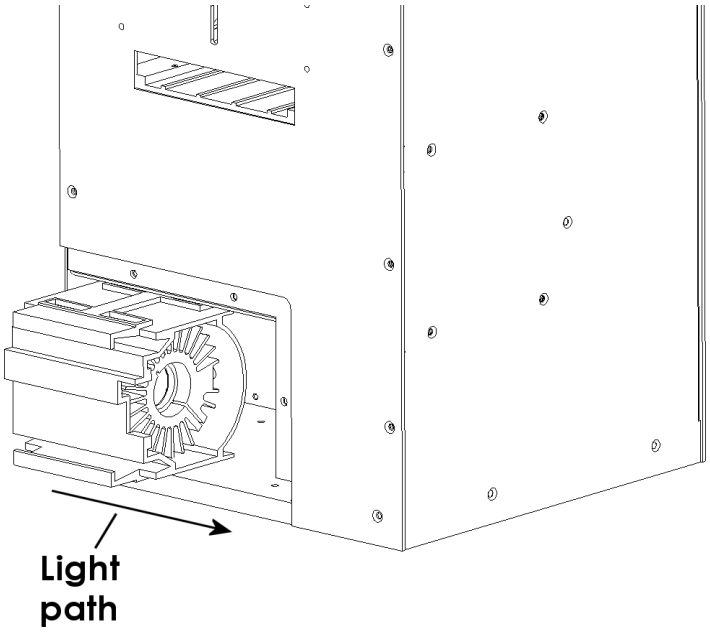


Figure 5-7. Returning the light bulb assembly to the system.

2. Reaffix the black cover panel and screw it in place with the four knurled screws.
3. Screw in the five screws at the lower left corner of the left side panel where the lamp access door is located.

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APPENDIX A. LIMITED WARRANTY

- Sutter Instrument Company, a division of Sutter Instrument Corporation, limits the warranty on this instrument to repair and replacement of defective components for two years from date of shipment, provided the instrument has been operated in accordance with the instructions outlined in this manual.
- The CERMAX bulb is covered for only 500 hours.
- Abuse, misuse, or unauthorized repairs will void this warranty.
- Warranty work will be performed only at the factory.
- The cost of shipment both ways is paid for by Sutter Instrument during the first three months this warranty is in effect, after which the cost is the responsibility of the customer.
- The limited warranty is as stated above and no implied or inferred liability for direct or consequential damages is intended.
- Consumables, PMTs, galvanometers, and Uniblitz®[1] shutters are exempt from this warranty.
- An extended warranty for up to three additional years can be purchased at the time of ordering, or until the original warranty expires. For pricing and other information, please contact Sutter Instrument.

[1] Uniblitz® is a registered trademark of Vincent Associates.

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APPENDIX B. ACCESSORIES

B.1. Liquid Light Guides and Other Accessories

LLG	Liquid light guide (2 meters, 3mm diameter), C-mount, lens and lens tube
LLG/380[2]	Liquid light guide (2 meters, 3mm diameter), C-mount, lens, and lens tube. Allows light input into near IR.

B.2. Microscope Mounting Adapters

Mounting adapters for Nikon, Zeiss, Leica and Olympus microscopes are available. Please refer to the Microscope Adapters section of Sutter Instrument's web site (http://www.sutter.com) for further information.

B.3. Xenon Arc Lamp Bulbs

The bulbs listed in the following do not include the outer blue housing. If an extra housing is required, please contact Sutter Instrument by phone, fax, or email.

O661176	Ozone free 175 Watt xenon bulb (attenuated output below 340nm)
O661175*	Full spectrum 175Watt xenon bulb
O661301	Ozone free 300 Watt xenon bulb (attenuated output below 340nm)
O661300*	Full spectrum 300 Watt xenon bulb
O661115	Housing and heat sink for bulb (bulb is installed when ordered at the same time as the housing)

**** WARNING: Full-spectrum bulbs produce ozone, which is toxic and must be eliminated from the area in which the Lambda DG-4/5 operates. Please be certain that you have proper ventilation – systems installed with full-spectrum bulbs must be connected to an ozone-removing device or system. Contact Sutter Instrument for more information.***

B.4. 18mm Interference Filter Accessories

DG-IF/18 *	Filter holder
X100118	Filter cup
X100148	Filter spacer
X100158	Retaining ring

B.5. 25mm Interference Filter Accessories

DG-IF	Filter holder
X100120	Filter cup
X100150	Filter spacer
X100160	Retaining ring

B.6. Neutral Density Filter Accessories

DG-ND	Filter holder
X664162	Filter cup

B.7. SmartShutter

IQ25-DG	25mm SmartShutter with housing to fit Lambda DG-4/DG-5.
LB-SC	Dedicated SmartShutter controller system, with serial and USB interface cables, power cord, and manual.

NOTE: For a full list of available accessories for the Lambda DG-4 and DG-5, refer to the Products section of Sutter Instrument's web site (http://www.sutter.com).

APPENDIX C. FUSE REPLACEMENT

In the event that the lamp fails to power up when the power switch is turned on, please check to see if the line power fuse has blown. The fuse is located in a pry-out holder on the power entry module on the back of the lamp (see Figure 3-2 on Page 16). To remove the fuse holder first unplug the power cord from the power entry module. This will reveal a slot just under the edge of the fuse holder. Use a screwdriver to pry the holder straight out of the power entry module.

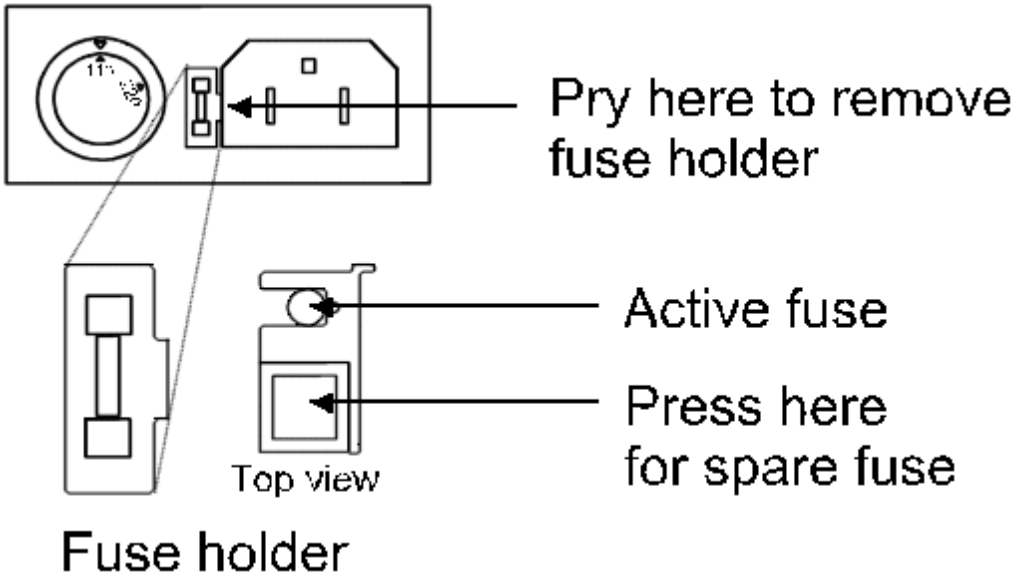

Figure 5-8. Fuse replacement.

The fuse that is readily visible in the fuse holder when you take it out is the one that is "active" when the holder is installed. A spare fuse is also stored within the fuse holder. It is concealed in a compartment as shown in the figure. To remove the spare fuse, press down on the end of the compartment and push it out of the other end. The old fuse can serve as a convenient tool for pushing the spare fuse compartment out. Replace the active fuse with the spare and re-install the fuse holder and power cord. If the lamp fails to power up with the new fuse installed, call Sutter Instrument technical support personnel for assistance.

The value of the fuse required is a function of both the line voltage and wattage of the bulb in the Lambda DG-4/5. The following table gives the correct fuse values. The fuse supplied with the unit is the correct value for the unit as configured if the destination country was known at the time the lamp was ordered. All fuses are "time delay" or "time lag" type, with a glass-tube construction, and with a physical size of 5mm x 20mm. Specific fuse ratings depend on the power of the xenon lamp used in the Lambda DG-4/5, as indicated in the following tables.

TableC-1. Mains fuse requirements according to lamp power ratings and line voltage.

Xenon Lamp Power Rating	Line Voltage: 100 - 120VAC (Voltage Switch Setting: 110V)			Line Voltage: 220 - 240VAC (Voltage Switch Setting: 220V)		
	Fuse Rating	Manufacturer Examples RoHS Compliant (Lead Free)?		Fuse Rating	Manufacturer Examples RoHS Compliant (Lead Free)?	
		Yes	No		Yes	No
125 Watts[1]	3.0A, 125V	Bussmann: GMC-3-R Littelfuse: 239 003.P	Bussmann: GMC-3A Littelfuse: 239 003	T2.0A, 250V	Bussmann: S506-2-R Littelfuse: 218 002.P	Bussmann: GDC-2A Littelfuse: 218 002
175 Watts	4.0A, 125V	Bussmann: GMC-4-R Littelfuse: 239 004.P	Bussmann: GMC-4A Littelfuse: 239 004	T3.15A, 250V	Bussmann: S506-315-R Littelfuse: 218 3.15P	Bussmann: GDC-3.15A Littelfuse: 218 3.15
300 Watts	5.0A, 125V	Bussmann: GMC-5-R Littelfuse: 239 005.P	Bussmann: GMC-5A Littelfuse: 239 005			

[1] NOTE: The 125-Watt lamp version of the DG-4/DG-5 is a discontinued product.

APPENDIX D. TECHNICAL SPECIFICATIONS

CE

Lamp:	
Output Range	**330 to 700 nm (ozone-free bulb) or 300 to 700 nm (full-spectrum bulb)**
Type	**175 or 300-Watt ozone-free or full-spectrum pre-aligned xenon arc bulb**
Life	**1,000 hours, expected lifetime**
Warranty	**500 hours, prorated**
Light Interference Filters:	
DG-4	**Four 25mm (1") diameter filters**
DG-5	**Two 25mm (1") and three 18mm diameter filters**
Switching Time between Adjacent Interference Filters:	**1.0 milliseconds**
Dimensions (H x W x D):	**48 x 25 x 25 cm (19 x 10 x 10 in)**
Weight:	**20 kg (45 lb)**
Light Guide:	
Core Type	**Liquid**
Length	**2 m (6.5 ft)**
Diameter	**3 mm (0.11 in)**
Electrical:	
Mains voltage	**110/220 V, 50/60 Hz**
Power consumption	**756 W**
Power cord	**10A, 250V, with safety ground plug**
Mains fuse (rear of cabinet)	**Time delay (or time lag) 5 x 20 mm glass tube. For specific fuse ratings, refer to APPENDIX C (FUSE REPLACEMENT)**

Cables

Table D-1. Cable specifications.

	Type	Max. Length	Ferrite at Controller End	Cabling
Parallel	DB-25	6 ft (1.829 m)	Fair-Rite #0443164-251 (See Note 1)	Dielectric separation of circuits. Foil shielding
Serial (RS-232)	DB-9	10 ft (3.048 m)	Fair-Rite #0443167-251 (See Note 1)	Connected to metal faceplates of connectors on both ends. (See Note 2.)

Note 1: Fair-Rite Products Corp., P.O. Box J, One Commercial Row, Wallkill, NY, 12589 USA

Note 2: The supplied 9-pin serial RS-232 cable is a "straight-through" cable (Pin 1 of one end wired to Pin 1 of the other, Pin 2 to Pin 2, etc.). Do not substitute the provided cable with a "null-modem" cable, or any cable that has Pins 2 and 3 crossed and/or connected to other non-corresponding pins.

APPENDIX E. EXTERNAL-CONTROL COMMAND REFERENCE

This appendix provides a complete list of remote control commands and return values.

Table E-1. Filter-selection command reference.

Byte Value			Keyboard Entry			Positioning					Light Beam	
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./-char.	Nominal Pos. Index	DG-4		DG-5		Interference	Movement …
							Filter	Attenuation	Filter	Attenuation		
0	00	00000000	Alt-0000	^@	(NUL)	0	0	0%	0	0%	**Blocked (shutter closed)**	**… on Command (Notes 1 & 2)**
1	01	00000001	Alt-0001	^A	(SOH)	1	1	100%	1	100%	**Selected filter blockage: None, ½, or 2/3**	
2	02	00000010	Alt-0002	^B	(STX)	2	2		2			
3	03	00000011	Alt-0003	^C	(ETX)	3	3		3			
4	04	00000100	Alt-0004	^D	(EOT)	4	4		4			
5	05	00000101	Alt-0005	^E	(ENQ)	5	1	50%	5			
6	06	00000110	Alt-0006	^F	(ACK)	6	2		1	50%		
7	07	00000111	Alt-0007	^G	(BEL)	7	3		2			
8	08	00001000	Alt-0008	^H	(BS)	8	4		3			
9	09	00001001	Alt-0009	^I	(HT)	9	1	33%	4			
10	0A	00001010	Alt-0010	^J	(LF)	10	2		5			
11	0B	00001011	Alt-0011	^K	(VT)	11	3		1	33%		
12	0C	00001100	Alt-0012	^L	(FF)	12	4		2			
13	0D	00001101	Alt-0013	^M	(CR)	13			3			
14	0E	00001110	Alt-0014	^N	(SO)	14			4			
15	0F	00001111	Alt-0015	^O	(SI)	15			5			
16	10	00010000	Alt-0016	^P	(DLE)	0	0	0%	0	0%	**Blocked (shutter closed)**	**… on Trigger (Notes 1, 2, & 3)**
17	11	00010001	Alt-0017	^Q	(DC1)	1	1	100%	1	100%	**Selected filter blockage: None, ½, or 2/3**	
18	12	00010010	Alt-0018	^R	(DC2)	2	2		2			
19	13	00010011	Alt-0019	^S	(DC3)	3	3		3			
20	14	00010100	Alt-0020	^T	(DC4)	4	4		4			
21	15	00010101	Alt-0021	^U	(NAK)	5	1	50%	5			
22	16	00010110	Alt-0022	^V	(SYN)	6	2		1	50%		
23	17	00010111	Alt-0023	^W	(ETB)	7	3		2			
24	18	00011000	Alt-0024	^X	(CAN)	8	4		3			
25	19	00011001	Alt-0025	^Y	(EM)	9	1	33%	4			
26	1A	00011010	Alt-0026	^Z	(SUB)	10	2		5			
27	1B	00011011	Alt-0027	^[	(ESC)	11	3		1	33%		
28	1C	00011100	Alt-0028	^\	(FS)	12	4		2			
29	1D	00011101	Alt-0029	^]	(GS)	13			3			
30	1E	00011110	Alt-0030	^^	(RS)	14			4			
31	1F	00011111	Alt-0031	^_	(US)	15			5			

NOTES:

1. Nominal Filter Position (Bits 0 – 3): Value range 0 through 15, and with Bit 4 = 1, 16 through 31.
2. Move on Command or Trigger (Bit 4): 0 (on command (i.e., immediately) or 1 (by trigger (see Note 3)).
3. "On trigger" means the light beam moves only on Strobe (strobe line), Synch (video synch), or Synch Gated by Strobe.

Table E-2. Filter selection command structure.

Functional Bit Groups								
Byte Bit #	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Group	**Unused (see note)**			**Move on Command or Trigger**	**Shutter Closed/Nominal Filter Position**			
Group Bit #				**0**	**3**	**2**	**1**	**0**
Decimal Group Values	0	0	0	0 – 1	0 – 15			
Hexadecimal Group Values	0	0	0	0 – 1	00 – 0F			
Binary Group Values	0	0	0	0 – 1	0000 – 1111			

NOTE: Byte Bits 7, 6, and 5 must all be set to 0 (zero) when the byte contains a filter selection command.

Formula for encoding Lambda DG- series filter wheel commands within a byte (numbers in decimal):

If Move on Command: (0 * 16) + *nominal position* = byte value

If Move on Trigger: (1 * 16) + *nominal position* = byte value

(*nominal position* = 0 – 15)

Table E-3. Special commands reference.

Byte Value			Keyboard Entry			Description
Dec.	**Hex.**	**Binary**	**Alt-keypad entry**	**Ctrl-char.**	**ASCII def./-char.**	
32 – 159	20 – 9F	00100000 – 10011111	Alt-0032 – Alt-0159		(space) – /	
170	AA	10101010	Alt-0170			**Open shutter**
171	AB	10101011	Alt-0171			**Dummy command to intersperse each command in a sequence of remote neutral density adjustment commands.**
172	AC	10101100	Alt-0172			**Close shutter**
173 – 185	AD – B9	10101000 – 10111001	Alt-0173 – Alt-0185			
186	BA	10111010	Alt-0186			**Activates turbo-blanking**
187	BB	10111011	Alt-0187			
188	BC	10111100	Alt-0188			**Inactivates turbo-blanking**
189 – 191	BD – BF	10111101 – 10111111	Alt-0189 – Alt-0191			
202	CA	11001010	Alt-0202			**Selects triggered by strobe line as the ring buffer mode**
203	CB	11001011	Alt-0203			**Deselects triggered by strobe line**
204	CC	11001100	Alt-0204			**Selects triggered by video synch as the ring buffer mode**
205	CD	11001101	Alt-0205			**Deselects triggered by video synch**
206	CE	11001110	Alt-0206			**Selects triggered by video sync gated by strobe line as the ring buffer mode**
207	CF	11001111	Alt-0207			**Deselects triggered by video sync gated by strobe line as the ring buffer mode**

Byte Value			Keyboard Entry			Description
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./-char.	
208 – 217	D0 – D9	11010000 – 11011001	Alt-0208 – Alt-0217			
218	DA	11011010	Alt-0218			**Freeze display**
219	DB	11011011	Alt-0219			**Turn display on**
220 – 222	DC – DE	11001100 – 11001110	Alt-0220 – Alt-0222			
223	DF	11011111	Alt-0223			**Start loading ring buffer**
224 – 233	E0 – E9	11100000 – 11101001	Alt-0224 – Alt-0233			
234	EA	11101010	Alt-0234			**Start the remote adjustment of neutral density setting for current filter position.**
235	EB	11101011	Alt-0235			**Increase value of Galvo DAC for neutral density setting of current filter position.**
236	EC	11101100	Alt-0236			**Decrease value of Galvo DAC for neutral density setting of current filter position.**
237	ED	11101101	Alt-0237			**End the remote adjustment of neutral density setting for current filter position and save**
238	EE	11011110	Alt-0238			**Set controller to On Line (serial or parallel port); pressing LOCAL key sets controller to off line).**
239	EF	11011111	Alt-0239			
240	F0	11110000	Alt-0240			**End loading ring buffer**
241	F1	11110001	Alt-0241			**Run from ring buffer**
242	F2	11110010	Alt-0242			**End run from ring buffer**
243 – 255	F3 – FF	11110011 – 11111111	Alt-0243 – Alt-0255			

NOTE: The "ASCII def./char." column for codes 128 through 255 (80 through FF hex) is left blank, since there are no ASCII character definitions for the codes in this range. However, many computers and operating systems do support characters within this range, although there is no single standard across all platforms. Furthermore, many operating systems, such as Microsoft Windows and Apple Mac OS X, have several "code pages" (character sets), many of which are country/language specific, from which the user can select. Therefore, this part of the table is left blank – if you wish, you may write in the characters defined in the character set you use on a regular basis.

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