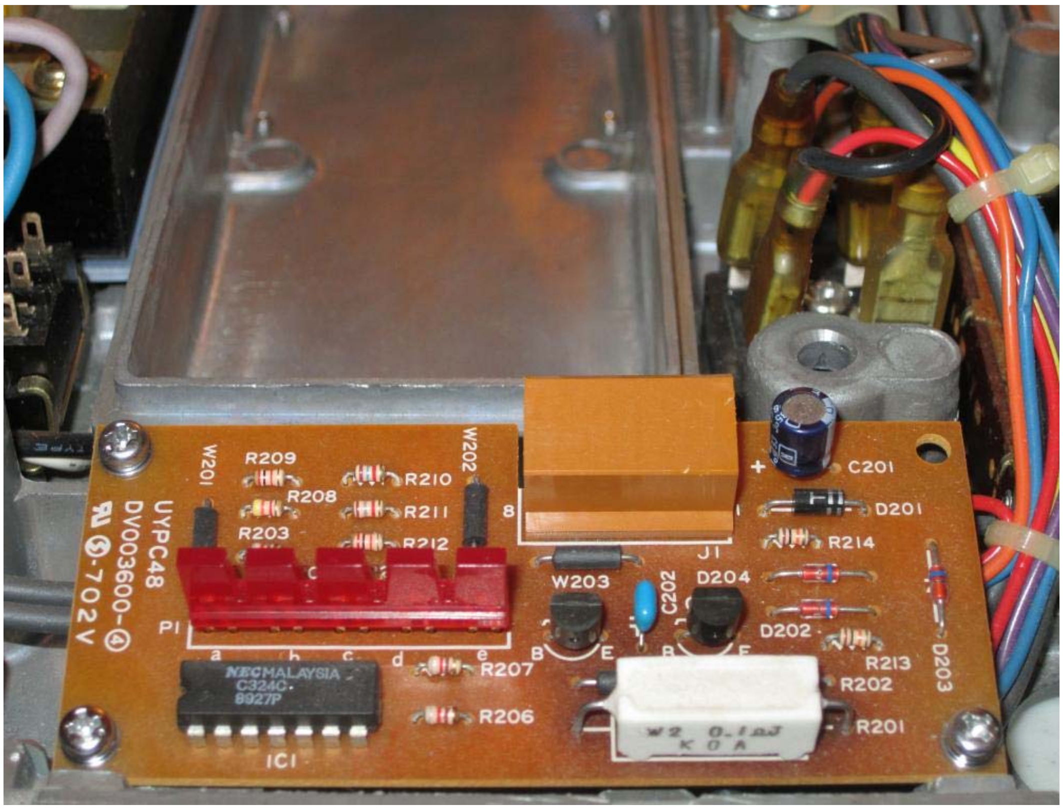
OLYMPUS
BH-2 (BHT/BHTU)
ELECTRONICS



Revision History

Revision	Description	Date
1	Initial release	June 17, 2014
2	Corrected error in circuit theory. Added vendor info, lamp house repair procedure, and light preset control / switch information.	March 17, 2016

Introduction

This document provides a detailed description of the electrical circuitry of the 100/115V version of the Olympus BHT and BHTU microscopes, which are part of the BH-2 family. The information contain herein is intended to supplement the information published in the *Olympus Research Microscope Series BH2 (BHS) Repair Manual*, by providing additional circuit details and a complete theory of operation, as well as correcting errors that were found in the circuit diagram published by Olympus. This information was obtained by performing tear-down inspections of functional BHTU microscopes configured for 100/115V operation.

Safety Warnings and Disclaimers

The content of this document is provided for informational purposes only, with no expressed or implied warranties whatsoever, including, but not limited to, function, suitability, safety, accuracy, and completeness of information.

Repairing your own microscope may seem like a hip and cool thing to do that will make you the envy of all of your friends, but *being dead* will not. Potentially lethal voltages are present inside these microscopes. Do not attempt repairs or troubleshooting if you lack the necessary skills, training, and confidence to safely perform repairs on line-powered electrical equipment. If you choose to attempt repairs or troubleshooting, do so at your own risk.

Overview of Electrical Circuitry

The electrical circuitry of the Olympus BHT/BHTU microscopes resides completely within the base of the microscope stand. AC power is provided by an AC inlet jack on the back, where the line cord connects. There is a power switch on the front to turn the illumination on and off, as well as an intensity control on the right-hand side to vary the lamp voltage. There is a voltage selector switch on the bottom of the base to allow operation under normal or low-line conditions, and enclosed within the base are a power transformer, a bridge rectifier, a main printed circuit board, and a power transistor. A 6V/20W halogen lamp resides in the lamp house on the rear of the stand. Later stands have a light preset switch and a screwdriver-adjustable light preset control, located just above the intensity slider, to provide preset lighting intensity for photographic applications.

The BHT/BHTU electronics performs two independent, yet related functions, in response to a variable control signal from the intensity potentiometer. The first function is intensity control of the halogen lamp. To provide this, the dimmer circuitry varies the voltage applied to the lamp in response to this control signal. The second function is display of the lamp voltage via a four-segment LED bar-graph display, which also operates off of the intensity control signal. Details of both of these circuit functions are described in the sections below.

Lamp Dimmer Circuitry

Figure 1 is a simplified schematic diagram of the lamp dimmer circuitry. This diagram contains the details necessary for an understanding of the basic operation of the lamp dimmer. Unnecessary details such as such as switching, fusing, electrical interconnects, and current limiting have been omitted for clarity. Refer to Appendix 2 and Appendix 3 of this document for complete and detailed schematic diagrams of the BHT/BHTU electronics.

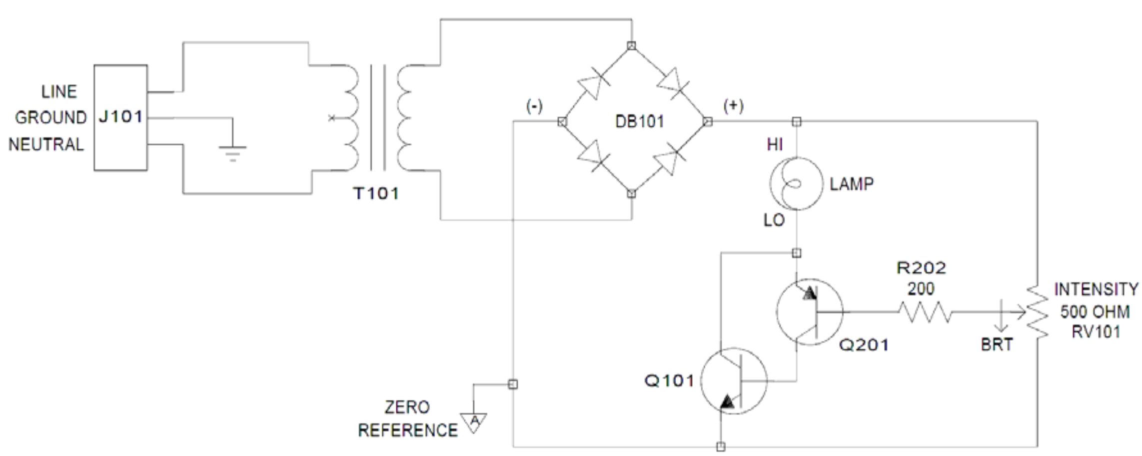


Figure 1 – BHT/BHTU Lamp Dimmer Circuitry (without Current Limiting)

Electrical power from the AC line is applied to the equipment via the AC line cord, which plugs into J101 on the back of the microscope base. Power transformer T101 converts the AC line voltage (120V or 240V, depending on which transformer is installed) to approximately 9V RMS on the secondary winding. The output of the secondary winding feeds into bridge rectifier DB101, whose full-wave-rectified output in turn feeds the lamp dimmer circuitry. Bridge rectifier DB101 is necessary to provide DC to the lamp dimmer circuitry, since transistors Q101 and Q201 in the dimmer circuit are bipolar junction devices which can conduct current in only a single direction.

Potentiometer RV101 controls the lamp intensity. When RV101 is adjusted for minimum intensity (i.e., the wiper is at the top end of its travel), the full output voltage of bridge rectifier DB101 is fed to the base of transistor Q201 via resistor R202. Under this condition, transistor Q201 will not conduct since the base-emitter junction is not forward biased and there will be no collector current in Q201, and therefore no base current in transistor Q101. Without base current, transistor Q101 will be cutoff and no current will flow through the lamp.

As potentiometer RV101 is moved from its minimum intensity position in the direction of increasing intensity (i.e., the wiper is moved towards the zero reference ground), the control signal feeding the base of transistor Q201 decreases, progressively forward biasing its base-emitter junction and allowing it to increasingly conduct collector current. Since the collector current of transistor Q201 is the base current of transistor Q101, Q101 in turn begins to conduct increasing amounts of collector current, which flows through the halogen lamp. The lower the amplitude of the control signal from the potentiometer, the higher the resulting lamp current and corresponding lamp intensity.

The overall DC current gain of the lamp dimmer is considerable, and is approximately equal to the product of the individual β values of transistors Q201 and Q101 (i.e., $\beta_{OVERALL} \sim \beta_{Q201} \times \beta_{Q101}$). Because of this high value for $\beta_{OVERALL}$, the halogen lamp will be fully illuminated with little base current in transistor Q201, thereby introducing only a minimal voltage drop across resistor R202. Neglecting this minimal drop, the voltage present on the bottom terminal of the lamp is approximately 0.7V higher than the control signal from the potentiometer, at any setting of the potentiometer (excluding the minimum-intensity setting, where there is no forward bias on the base-emitter junction of transistor Q201). This means that the lamp voltage may be adjusted from zero at one extreme of the intensity control to nearly the full output voltage of DB101 at the other extreme of the intensity control.

Figure 2 is the lamp dimmer circuitry shown in Figure 1 with the addition of transistor Q202, resistor R201, and capacitor C202. These three components provide a current-limiting function for the dimmer, to prevent damage to the lamp in the event of power surges on the AC line and to minimize thermal stresses on the lamp at power-up.

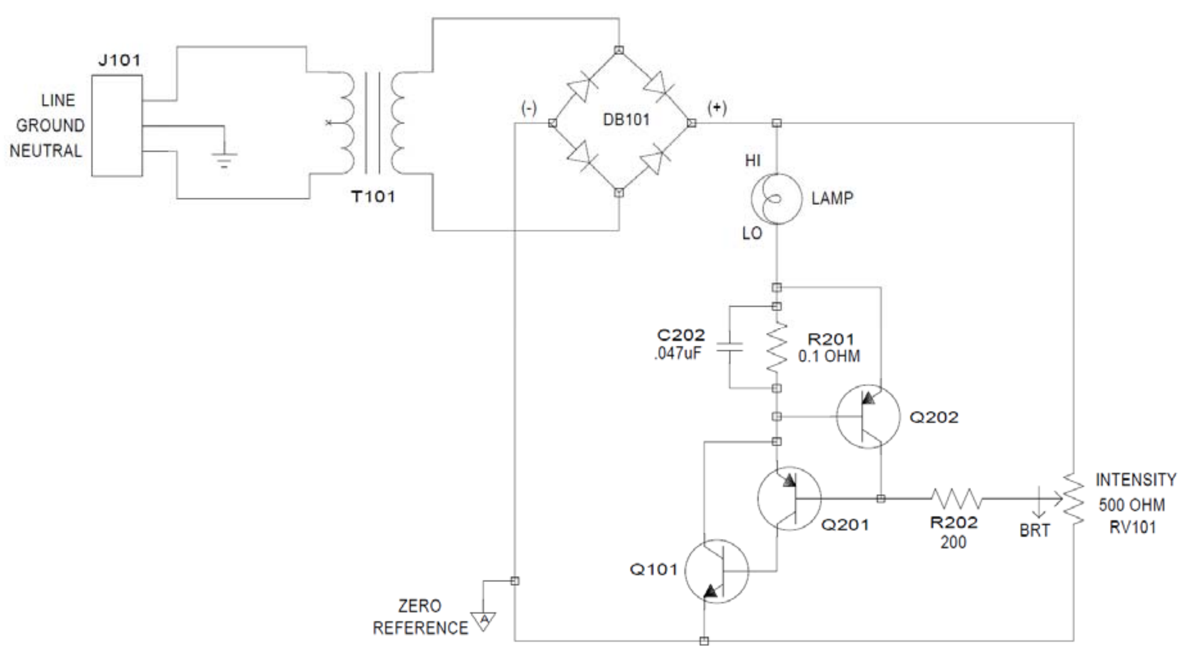


Figure 2 – BHT/BHTU Lamp Dimmer Circuitry (with Current Limiting)

Resistor R201, the current-sensing resistor, is effectively in series with the halogen lamp. So long as the lamp current remains within the normal range, the resulting voltage drop across resistor R201 is insufficient to initiate conduction of transistor Q202, and the dimmer operates as described in the paragraphs above. However, if for any reason the lamp current gets high enough that the voltage drop across resistor R201 is sufficient to turn on transistor Q202, the resulting collector current of transistor Q202 shunts the base-emitter junction of transistor Q201, reducing its base current and in turn reducing the lamp current. This negative-feedback mechanism limits the peak lamp current to approximately 7.3A. Capacitor C202 provides low-pass filtering for the base of transistor Q202, preventing any high frequency noise or RF from affecting the lamp dimmer.

Figure 21, Figure 22, and Figure 23 show the voltage and current waveforms of the halogen lamp with the dimmer operating at the 100%, 50%, and 20% settings of the intensity control, respectively. Figure 24 shows the dimmer operating under current-limiting conditions at the 80% setting of the intensity control and with an abnormally low lamp resistance of 0.2 Ω.

LED Bar-Graph Display Circuitry

Figure 3 is a simplified schematic diagram of the LED bar-graph display circuitry. This diagram contains the details necessary for an understanding of the basic operation of the LED circuitry. Unnecessary details such as such as switching, fusing, and electrical interconnects have been omitted for clarity. Refer to Appendix 2 and Appendix 3 of this document for complete and detailed schematic diagrams of the BHT/BHTU electronics.

This circuit successively illuminates the four LEDs in the bar-graph module as the intensity control is moved from its minimum setting to its maximum setting. The variable output from the wiper of potentiometer RV101 acts as the control signal for the LED display circuitry (as well as for the dimmer circuit described earlier), which feeds the non-inverting inputs of four op-amps used as comparators. The control signal is at maximum amplitude at the minimum intensity setting, and is at zero amplitude at the maximum intensity setting. The four comparators each have specific switching thresholds, which are configured to allow the comparators to illuminate the LEDs at four pre-defined lamp voltages of 2V, 4V, 6V, and 7V, in response to the decreasing control signal from the intensity potentiometer.

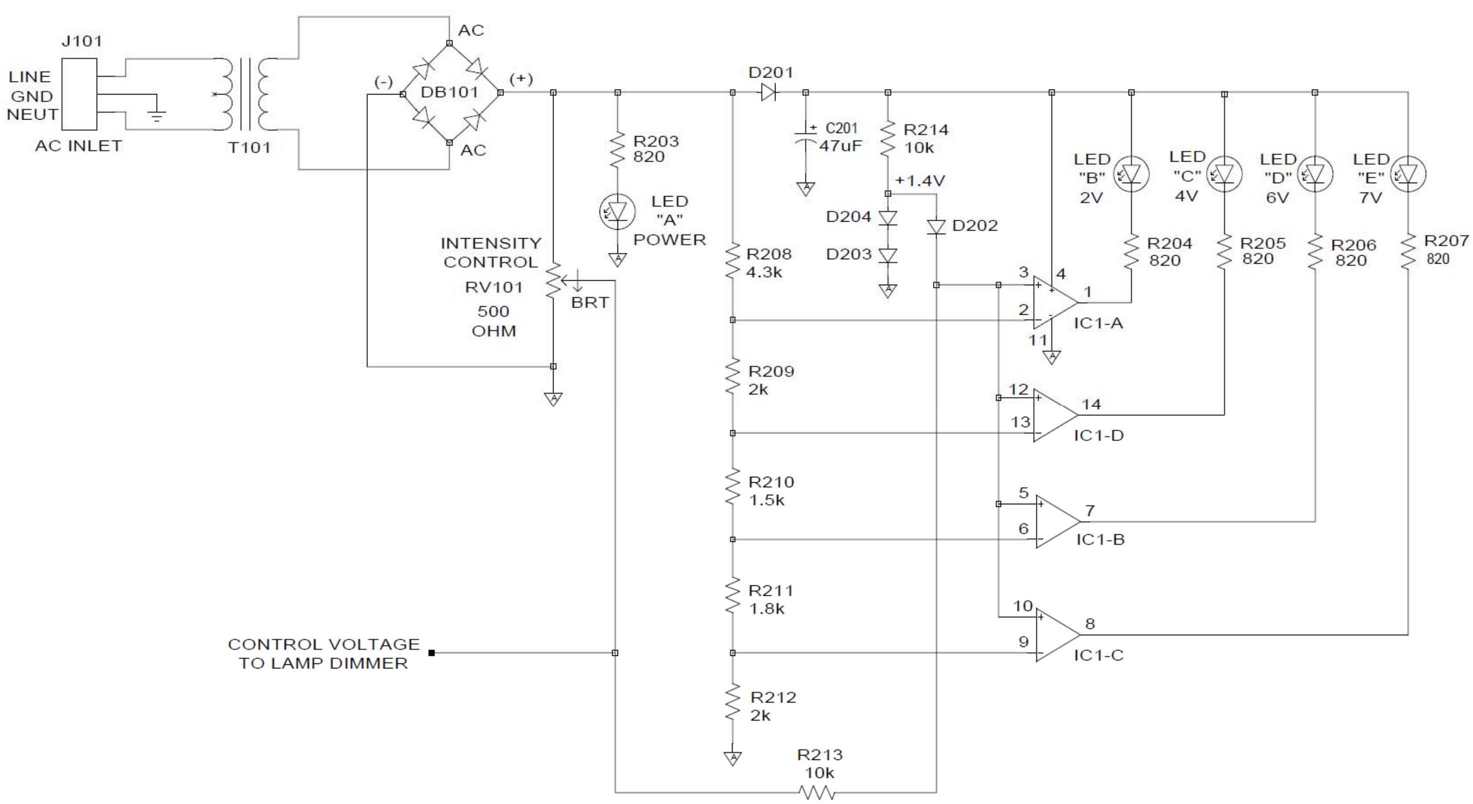


Figure 3 – BHT/BHTU LED Bar-Graph Display Circuitry

Filtered DC Power Supply

Diode D201 and capacitor C201 operate as a peak detector to produce filtered DC power from the full-wave-rectified output of bridge rectifier DB101. This filtered DC power line supplies power to the comparators and their respective LEDs. The AC ripple present on this line depends on the amount of current pulled by the comparators and LEDs. At minimal commanded lamp intensity (i.e., with all four LEDs in the off state), very little current is required and the voltage on this line is approximately +10.5V with little AC ripple. As the lamp intensity is increased (and the LEDs begin to successively illuminate), the current drain on this line increases as does the resulting AC ripple. When the lamp is at maximum intensity, all four LEDs are illuminated and the AC ripple is at its maximum, resulting in an average voltage on the filtered DC power supply line of approximately +9.5V. Figure 25 shows the ripple voltage on the filtered DC power supply line with the equipment operating under worst-case ripple conditions of maximum lamp intensity. The green trace is the positive output of bridge rectifier DB101 and the blue trace is the filtered DC power supply line.

Comparator Thresholds

The switching thresholds of the four op-amp comparators are provided by a four-stage voltage divider consisting of resistors R208, R209, R210, R211, and R212. These thresholds are configured to allow the comparators to illuminate the LEDs at pre-defined lamp voltages of 2V, 4V, 6V, and 7V, in response to the decreasing control signal from the intensity potentiometer. Figure 26 shows the threshold voltages on the inverting pins of the op-amp comparators. The green trace is the positive output of bridge rectifier DB101, from which the four threshold voltages are derived. The blue, red, cyan, and magenta traces are the threshold voltages on the inverting inputs of IC1-A, IC1-D, IC1-B, and IC1-C, respectively.

Control-Signal Clamp

Resistors R213 and R214, and diodes D202, D203, and D204, clamp the voltage level of the intensity control signal from potentiometer RV101 to keep the non-inverting inputs of the comparators from ever dropping below approximately +0.7V. This is necessary to prevent the LEDs from illuminating briefly during the intervals where both the wiper of potentiometer RV101 and the comparator thresholds drop to zero at the zero crossings of the AC line. If both inputs to the comparators were allowed to simultaneously drop to zero, the comparators would be in an indeterminate state, and depending on the input-offset voltage parameters of the specific op-amp devices, their outputs could pull low during these intervals, resulting in one or more LEDs not fully extinguishing when they should.

The operation of the control-signal clamp is as follows. Resistor R214 feeds a DC current through the two series-connected silicon diodes, D203 and D204, producing a potential on the anode of diode D204 two diode drops above ground (approximately +1.4V). The anode of diode D202 connects to this +1.4V node and its cathode connects to the non-inverting inputs of the four comparators. Resistor R213 couples the control signal from potentiometer RV101 to the non-inverting inputs of the comparators. Any time the control signal is low enough to forward bias diode D202, the voltage on the non-inverting inputs of the comparators is clamped to approximately +0.7V (i.e., one diode drop less than +1.4V). As the voltage on the wiper of RV101 increases, diode D202 turns off and is effectively out of the circuit, thereby providing no further clamping action. This mechanism allows the intensity control signal to swing positive without restraint, but prevents it from dropping below approximately +0.7V. Figure 27 shows the waveform of the clamped control signal at the 50% setting of the intensity control, as measured at the non-inverting inputs of the comparators.

Voltage Comparators

Integrated circuit IC1 is a NEC uPC324C quad operation amplifier. All four sections of IC1 are operated open-loop as voltage comparators and are configured to drive the four bar-graph LEDs in response to the clamped control signal from potentiometer RV101. Each comparator illuminates its associated LED by driving its output low during the intervals where the clamped control signal drops below its threshold voltage, and extinguishes its LED by driving its output high during the intervals where the clamped control signal exceeds its threshold voltage. Figure 28 shows the operation of one of the comparators (IC1-B) with the 6V LED illuminated. In these waveforms, the intensity control is set to the 70% setting. The green waveform is the threshold voltage present on the inverting pin of IC1-B, and the blue waveform is the clamped control signal on the non-inverting pin of IC1-B. During the intervals where the control signal is below the threshold voltage, the comparator output pulls low, illuminating the 6V LED, and during the intervals where the control signal is clamped to approximately +0.7V (and is exceeding the threshold voltage), the comparator output pulls high, extinguishing the 6V LED. If the setting of the intensity control is decreased to the point where the clamped control signal exceeds the threshold waveform, the 6V LED will completely extinguish. The operation of the remaining three comparators is similar to this one, differing only in their threshold voltages.

Power LED
Resistor R203 and LED "A" function as the power-on indicator for the microscope.

Errors in the Olympus Documentation
In the course of researching this document, two errors were identified in the schematic diagram published in the *Olympus Research Microscope Series BH2 (BHS) Repair Manual*. Both of these errors are in the LED bar-graph display circuitry.

Bar-Graph LEDs
The first error is in the wiring of the four bar-graph LEDs, as shown in Detail 1 of Appendix 2 and Appendix 3 of this document. The Olympus manual shows these LEDs wired with their cathodes connecting to their respective comparator outputs and with their anodes wired to their respective current-limiting resistors. The actual circuit configuration (as observed on the main boards of functional BHTU equipment) has the anodes of the four LEDs connected to the filtered DC power supply line and the cathodes connected to their respective current-limiting resistors. This is a minor discrepancy and either configuration would work equally well, but the actual as-built configuration is shown in this document.

Control-Signal Clamping Network
The second error is in the wiring of the control-signal clamping network, as shown in Detail 2 of Appendix 2 and Appendix 3 of this document. The Olympus manual shows this network fed from the full-wave-rectified output of the bridge rectifier, but in the actual circuit configuration (as observed on the main boards of functional BHTU equipment), this network is fed from the filtered DC power supply line. This error is of greater consequence than the first, as the circuit published in the Olympus repair manual would not guarantee that the LEDs remain off around the zero crossings of the AC line.

Removing the Electrical Base from the Stand
To gain access to the electronics in the base of the BHT/BHTU stand, the electrical base must be removed from the base of the stand. Be sure to take sufficient notes and plenty of photographs both before and during the disassembly process to make sure that everything can be correctly reassembled later on. Before removing the electrical base, look at the right-hand side of the unit, just above the intensity slider, and note whether or not a light preset control and switch are present. The earlier units did not include these components, but the later ones did.

Next, remove all the major components from the microscope stand (i.e., AC power cord, condenser, stage, eyepieces, viewing head, and objectives). Doing so will make the stand easier to maneuver and will prevent inadvertent damage to these components during disassembly and reassembly. Be sure to protect these components from dust and damage while they are not installed on the stand.

After removing these components, cover the top of the arm (i.e., the nosepiece turret and the exposed mounting dovetail for the viewing head) with a clean plastic bag and secure this with a rubber band to keep dust out of these openings. This is especially important on BHTU stands which have an optical correction lens located just below the viewing head to correct for the difference in tube length introduced with the reversed nosepiece.

With the stand in its normal upright position, remove the lamp house from the back of the base. The lamp house simply plugs into the base, and can be removed by grasping it and pulling it straight back. Set the lamp house aside to prevent damage. Do not touch the halogen lamp with your fingers, as oils from your skin will cause premature failure of the bulb. If the bulb is accidentally touched, clean it with isopropyl alcohol.

Carefully turn the stand upside down, exercising caution to prevent impacts to the focus knobs and to the condenser/stage holder. Using a 5/32" Allen tool, remove the four hex socket-head cap screws from the bottom of the stand, as shown in Figure 4. Hold the electrical base in place and set the stand in its normal upright position on a flat surface, being careful not to let the electrical base shift as you do so.

Lift the stand from the electrical base by grasping the arm and lifting straight up until the bottom of the stand well clears the electrical base. If the unit contains a light preset control and switch, be sure to disengage the printed circuit board containing the preset control and switch from the notch in the side of the base before lifting the stand clear of the electrical base.

The stand, without the electrical base, may now be placed on a clean flat surface in its normal upright position. With the electrical base removed, the fragile illumination components are exposed on the open bottom of the stand and may be damaged if the stand is not placed on a suitable clutter-free surface. Store the stand someplace out of harm's way and where dust and debris will not accumulate on the exposed lighting components.

Figure 4 – Bottom View of BHT/BHTU Electrical Base (100/115V Version)

Setting Up for Troubleshooting the Base

Set the electrical base on a suitable work surface. If the unit includes a light preset control/switch, orient the printed circuit board containing the control and switch such that it will not make contact with the chassis or any other electrically conductive items during the troubleshooting process.

Carefully plug the lamp house into J103 on the rear of the electrical base, as shown in Figure 5, making sure both contact pins of the lamp house engage the mating receptacles of J103. The lamp house will be fragile and unsupported when plugged into the electrical base without the stand, since the two alignment/support pins on the lamp house will not be engaged with the mating holes in the stand. Once again, do not touch the halogen lamp with your fingers.

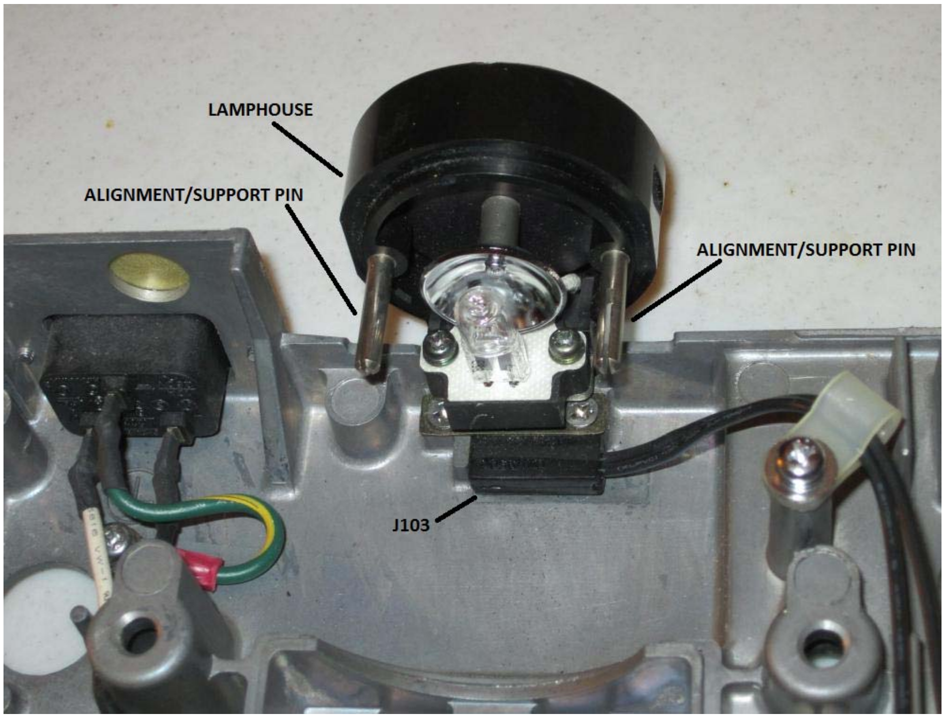


Figure 5 – Lamp House Plugged into J103 of BHT/BHTU Electrical Base (100/115V Version)

With the AC line cord unplugged from the wall receptacle and with the AC power switch on the front of the unit in the *OFF* position, plug the line cord into the AC inlet jack on the rear of the base. ***Exercise extreme caution from this point forward, as potentially lethal line voltage will be present at various exposed points within the electrical base***. Plug the AC line cord into a properly grounded AC receptacle. The electronics may now be operated as necessary for troubleshooting purposes. ***Never operate the microscope if the chassis bonding screw for the ground (center) pin of the AC inlet jack is loose or missing, or if the wire to this lug is cut or damaged (see Figure 6).*** These are critical safety components and are necessary to ensure that the chassis of the microscope is always at a safe potential in the event of any electrical faults within the equipment.

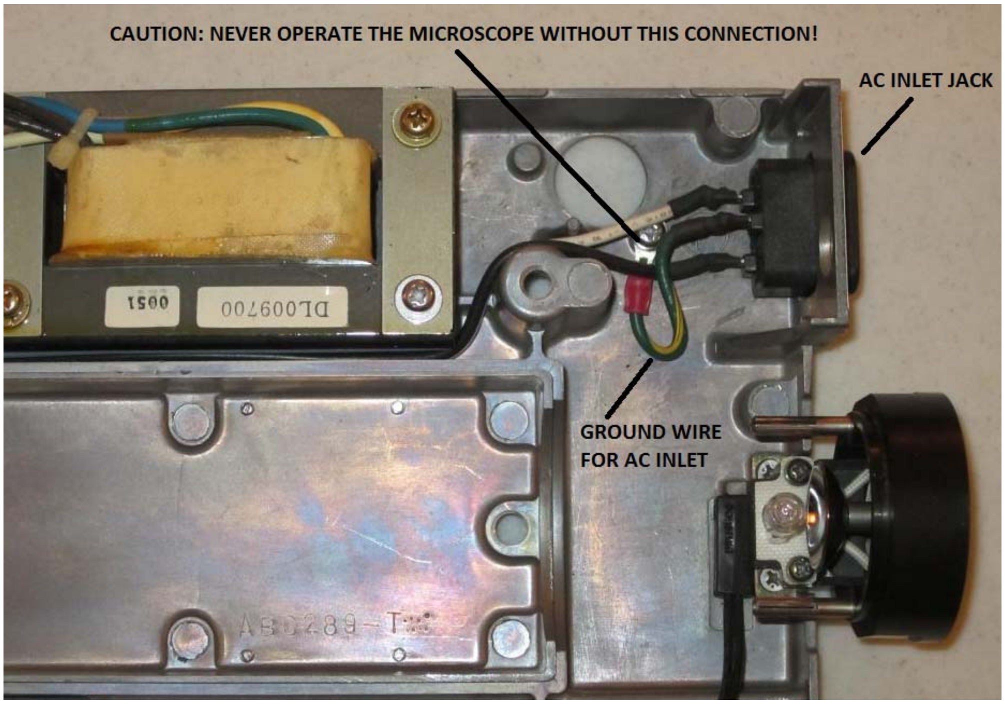


Figure 6- Safety Ground Connection for AC Inlet Jack of BHT/BHTU Electrical Base (100/115V Version)

Common Problems with the BHT/BHTU Electronics

The electronics in the BHT/BHTU microscopes have proven to be remarkably reliable over the years, but with heavy usage, failures do occur. The most likely problems in the electronics will be bad or intermittent contacts in the lamp house and erratic lamp intensity due to dust, dirt, and oxidation within the intensity control.

Worn or oxidized contacts in the socket in the lamp house will cause the halogen bulb to not illuminate, to flicker, or to illuminate only intermittently. If a replacement lamp house is not available, the troublesome lamp socket may be replaced with a new one, as described later in this document. It may also be possible to effect a temporary repair by disassembling the existing lamp socket and cleaning the oxidized contacts with emery paper, but this should be viewed as a temporary fix only.

Dust, dirt, and oxidation within the intensity control can cause erratic lamp intensity as the control slider is moved throughout its adjustment range. This can usually be corrected by spraying a short blast of volume control/contact cleaner (after unplugging the AC line cord) into the intensity control and moving the slider throughout its full range of motion a few times to distribute the cleaner (see Appendix 1 of this document for a suggested cleaner). Exercise caution when spraying the cleaner into the control so as to minimize overspray and blow-back onto nearby components. Be sure to allow the contact cleaner sufficient time to evaporate out of the control before re-applying power to the electrical base.

Obtaining Replacement Components

The BHT/BHTU microscopes are no longer supported by Olympus, and with few exceptions, factory replacement parts are not available. Some electrical parts (or suitable substitutes) are available from third party sources, and these parts are listed in Appendix 1 of this document, along with sources and pricing.

The BHT/BHTU microscopes were very popular in their day, and used stands and their various bits and pieces frequently show up for sale on ebay. If necessary, replacement electrical components can be salvaged from a spare electrical base. If exact replacements cannot be found, make sure that any substitute parts chosen for repairs have suitable electrical and mechanical specifications and that they are installed in such a way that it is not possible for the operator to contact any live voltage points while using the microscope.

Power Transformer

The good news here is that the power transformer (shown in Figure 7) rarely fails. The bad news is it may be difficult to locate a suitable substitute for it if it ever does fail, due to the unique form factor which allows it to fit into the base of the BHT/BHTU stand. If a suitable substitute cannot be found for the transformer, this may be a good time to start on that LED conversion project, while looking for another electrical base.

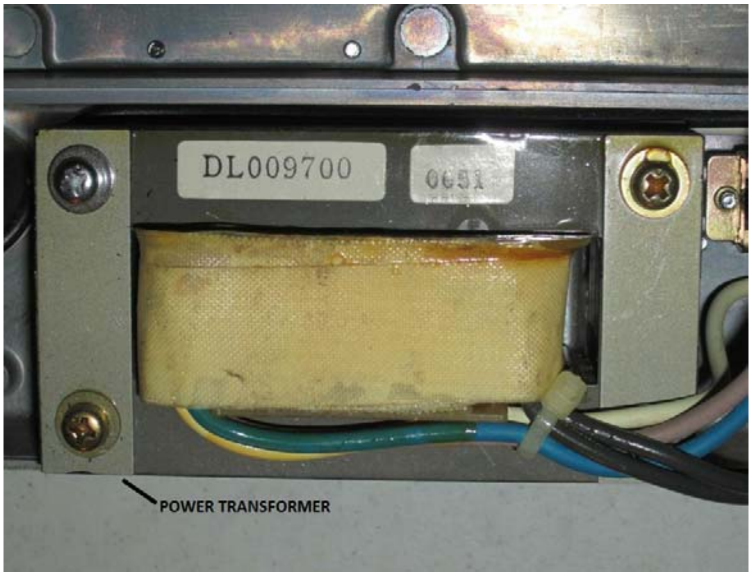


Figure 7 – Power Transformer Mounted to BHT/BHTU Electrical Base (100/115V Version)

Bridge Rectifier

The bridge rectifier is an S15VB10 (100V 15A) chassis-mount bridge rectifier with push-on terminals (see Figure 8). Look for a substitute with a continuous current rating of 15A or more and a PIV rating of at least 100V. Suitable substitutes are the NTE5322, KBPC1501, or KBPC1502. Be sure to install the replacement with thermal paste filling the interface between the part and the chassis, to facilitate heat flow. The NTE5322 is available from Allied Electronics and from Amazon.

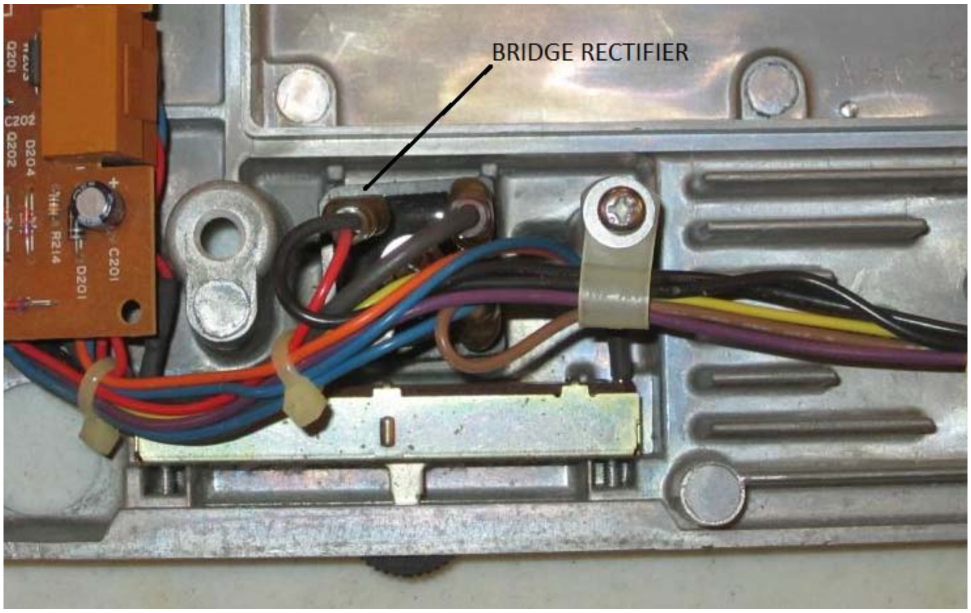


Figure 8 - Bridge Rectifier Mounted to BHT/BHTU Electrical Base (100/115V Version)

Lamp Intensity Control

The lamp intensity control is a 500Ω sliding potentiometer, with linear taper, and was manufactured by Noble (see Figure 9). It has 60mm of travel, and the mounting holes are spaced 65mm on center. Before replacing this part, try cleaning it with volume control/contact cleaner (with power removed from the equipment). Look for a substitute with a power rating of at least 1/2W.

Figure 9 – Lamp Intensity Control Mounted to BHT/BHTU Electrical Base (100/115V Version)

Light Preset Board

The light preset board, which is present on later stands only, contains a single-turn, 500Ω linear taper potentiometer and an SPDT rocker switch (see Figure 10). When the rocker switch is in the *OFF* position, the intensity slide potentiometer controls the lighting intensity, and when the switch is in the *ON* position, the screwdriver-adjust potentiometer controls the lighting intensity. The schematic for the light preset board is included in Appendix 3 of this document. A suitable replacement for the potentiometer could likely be found, if necessary. However, the rocker switch is more problematic, since it is this switch which supports the light preset board in the chassis. Since this board is not necessary for basic operation of the illumination system, it may be removed and electrically bypassed if suitable replacement parts cannot be found, or to permit the installation of a newer electrical base into an earlier stand that does not have the chassis notches to accommodate this board.

Removing and Bypassing the Light Preset Board

Remove the light preset board from the electrical base by unplugging the two connectors from J1 and J2 on the circuit board. Next, cut the two connectors off of the wires, making the cuts as close to the connector shells as practical, in order to leave sufficient wire lengths for the remaining steps. Strip the ends of the two orange wires that were connected to the four pin connector and solder them together, insulating with heat-shrink tubing in order to prevent shorting to the chassis. Do the same thing for the two blue wires (one was connected to the two-pin connector and the other was connected to the four-pin connector) and the two red wires (one was connected to the two-pin connector and the other was connected to the four-pin connector). Be sure to route these spliced wires such that they will not be pinched and will not interfere with the optical path of the illumination system once the stand is reassembled.

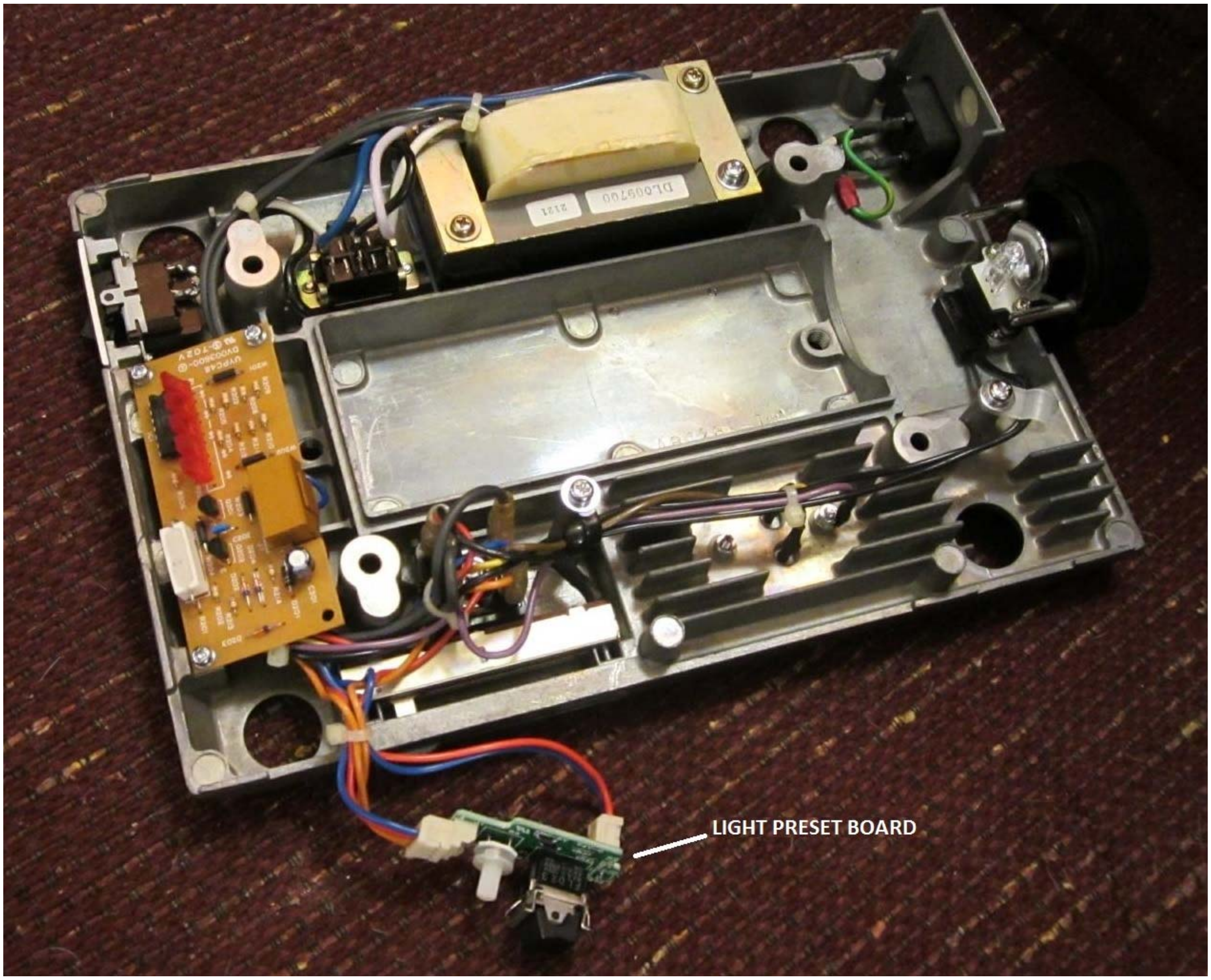


Figure 10 – Olympus DV2288-01 Light Preset Board on Later BHT/BHTU Electrical Base (100/115V Version)

AC Power Switch

The AC power switch (see Figure 11) is an Alps SDT-7 chassis-mount DPST rocker switch with a TV-5 rating for UL/CSA. This switch cannot be cleaned with control/contact cleaner since there are no openings to inject the cleaner. The mounting holes of this switch are spaced 34mm on center.

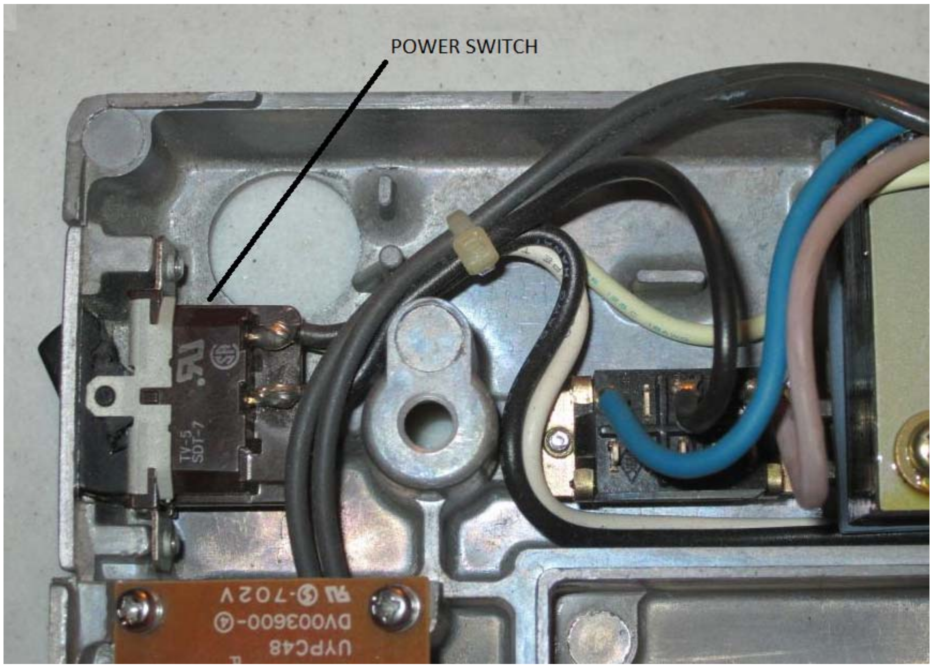


Figure 11 – AC Power Switch Mounted to BHT/BHTU Electrical Base (100/115V Version)

Voltage Selector Switch

The voltage selector switch (see Figure 12) is a chassis-mount DPDT slide switch rated for 4A/125VAC and 2A/250VAC. The slide protrudes 3/8" from the mounting surface and the mounting holes are spaced 1-1/8" on center. There are openings on both ends of this switch through which control/contact cleaner may be sprayed while the slider is positioned at the opposite end (with power removed from the equipment). The low-voltage position of this switch is rarely needed, and if a compatible replacement cannot be found, the switch could simply be bypassed in order to hardwire the microscope to operate at its nominal operating voltage. Since only one pole on this switch is used, a SPDT replacement could be used.

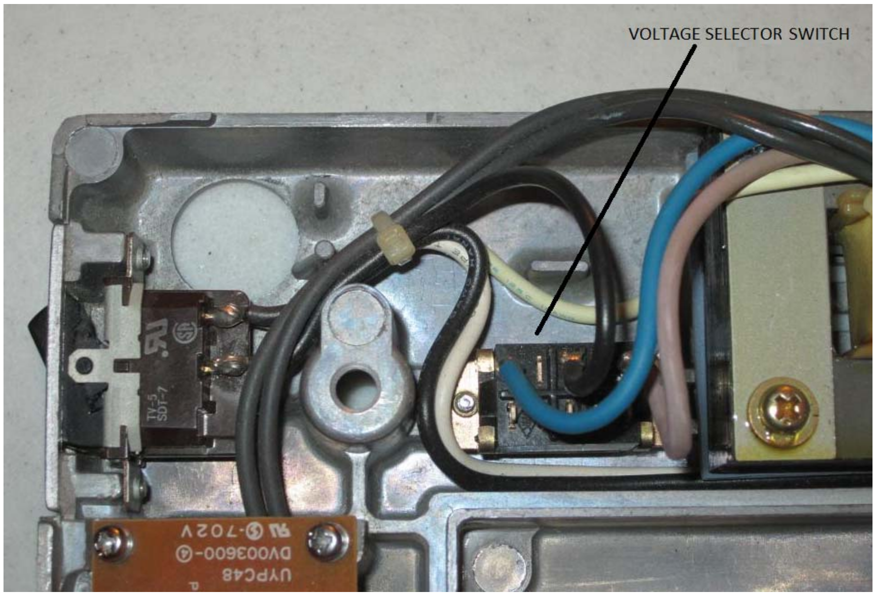


Figure 12 – Voltage Selector Switch Mounted to BHT/BHTU Electrical Base (100/115V Version)

Main Board

A replacement for the UYPC48 main printed circuit board (see Figure 13) is rarely needed, since the circuitry on this board is quite simple and can usually be repaired when necessary. Suitable replacements for most components can be readily found. The 5-LED module would be the hardest part to find, but could be replaced with five separate rectangular LEDs if necessary. The uPC324C op-amp can be replaced with the LM324C, in the DIP package. Transistors Q201 and Q202 may be replaced with 2N3906 PNP devices (be sure to account for differences in pinout when installing these as replacements). Diode D201 can be replaced with a 1N4002 or 1N4004 rectifier diode, and diodes D202, D203, and D204 can be replaced with 1N916 or 1N4148 small-signal diodes. The 0.1Ω 5W power resistor, R201, runs very hot during normal operation, and because of this the solder joints can sometimes go bad. Resoldering the leads of R201 may be enough to fix an inoperative lamp dimmer. Resistor R201 can be replaced with a Vishay CP0005R1000JE14 part, available from Mouser Electronics.

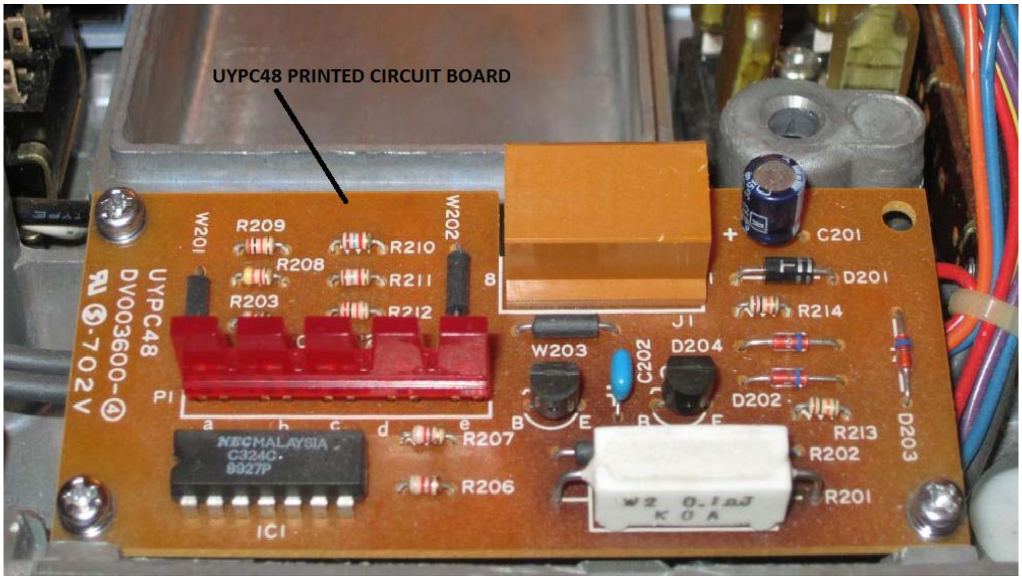


Figure 13 – Olympus UYPC48 Main Board Mounted to BHT/BHTU Electrical Base (100/115V Version)

In the rare case that the main board is damaged beyond repair, an aftermarket replacement for the Olympus UYPC48 main board is available from J.C. Ritchey Company, LLC (see Figure 14). This board, which is a drop-in replacement for the original Olympus board, comes complete with a replacement power transistor and the necessary transistor mounting insulator. No soldering is required for this option if only the circuit board needs to be replaced, but soldering is required if the power transistor is to be replaced at the same time. This looks to be a faithful reproduction of the original Olympus board and should perform well.

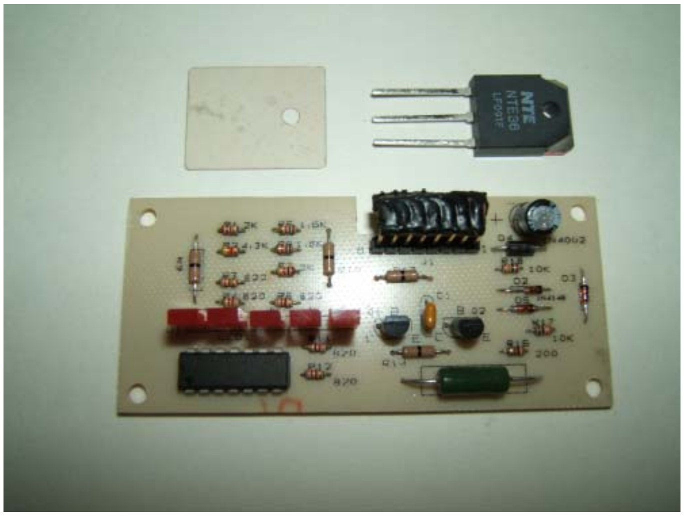


Figure 14 – BHT/BHTU Main Board Replacement Kit from J.C. Ritchey Company (photo courtesy James Ritchey)

Power Transistor

Power transistor Q101 is a Toshiba 2SD867 NPN power transistor in the old TO-3 metal package (see Figure 15). This part, although obsolete, can still occasionally be found, but expect to pay $20 or more for it when you find it. If the 2SD867 cannot be found, this part can be replaced with the STMicroelectronics BUX10 part, which is the same package style and is also obsolete. The NTE36 part in the TO-3P insulated case is a good substitute that is available from Allied Electronics and from Amazon.

Whichever approach is taken, the replacement transistor must be installed using suitable mounting hardware which provides electrical isolation of the collector tab from the equipment chassis, and thermal paste must be used on both sides of the insulator to enhance thermal conduction. If none of the parts listed above can be found, look for an NPN part with a collector current rating of at least 15A, a collector-to-emitter voltage rating of at least 100V, and a current gain of at least 40, in a suitable power package.

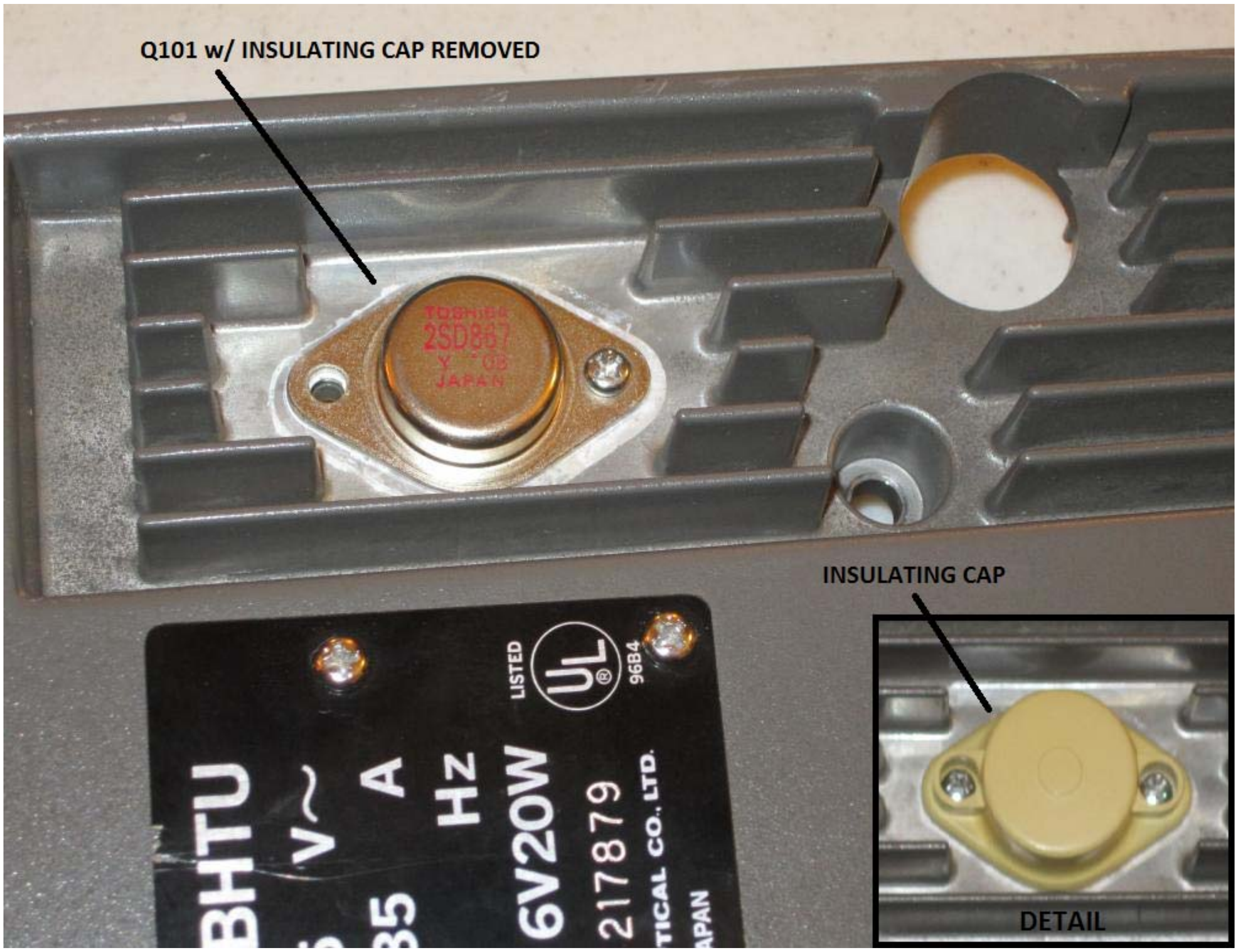


Figure 15 - Power Transistor Mounted to BHT/BHTU Electrical Base (100/115V Version)

AC Inlet Jack

For safety, always replace the AC inlet jack with an equivalent part, when available (see Figure 16). Make sure that the chassis-bonding screw for the ground (middle) terminal of the jack is present and secure and that the grounding wire is undamaged before operating the equipment. This connection keeps the chassis at a safe potential in the event of any electrical faults within the equipment.

If a suitable replacement jack cannot be located, a filler plate could be fabricated to take the place of the AC inlet jack, with a suitable hole drilled to allow an AC line cord to be installed with a strain-relief grommet. ***If this approach is chosen, be sure to securely bond the ground conductor of the power cord to the unit chassis to maintain equipment safety.***

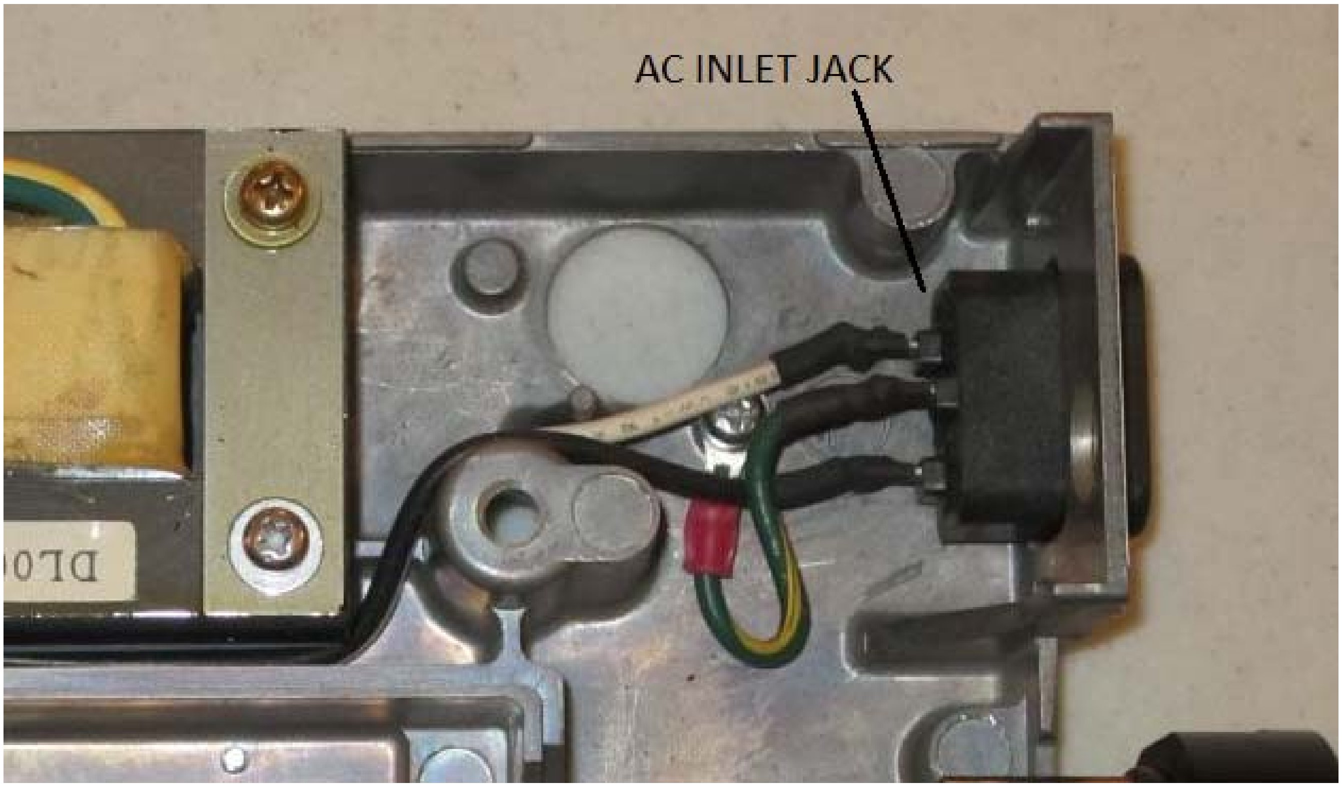


Figure 16 - AC Inlet Jack Mounted to BHT/BHTU Electrical Base (100/115V Version)

<u>Lamp House</u>

There were two styles of lamp house used on the BHT/BHTU microscopes (see Figure 17). The original LS20-H version supplied by Olympus (as part number 5-LB402) did not have a metal reflector behind the bulb. Later in the life of the BHT/BHTU, Olympus upgraded the lamp house to the LS20H-M2 (part number 5-S119), which incorporated a reflector behind the lamp in order to provide more usable light. Since the LS20H-M2 lamp house is directly interchangeable with the earlier LS20-H part, it should be used whenever possible.

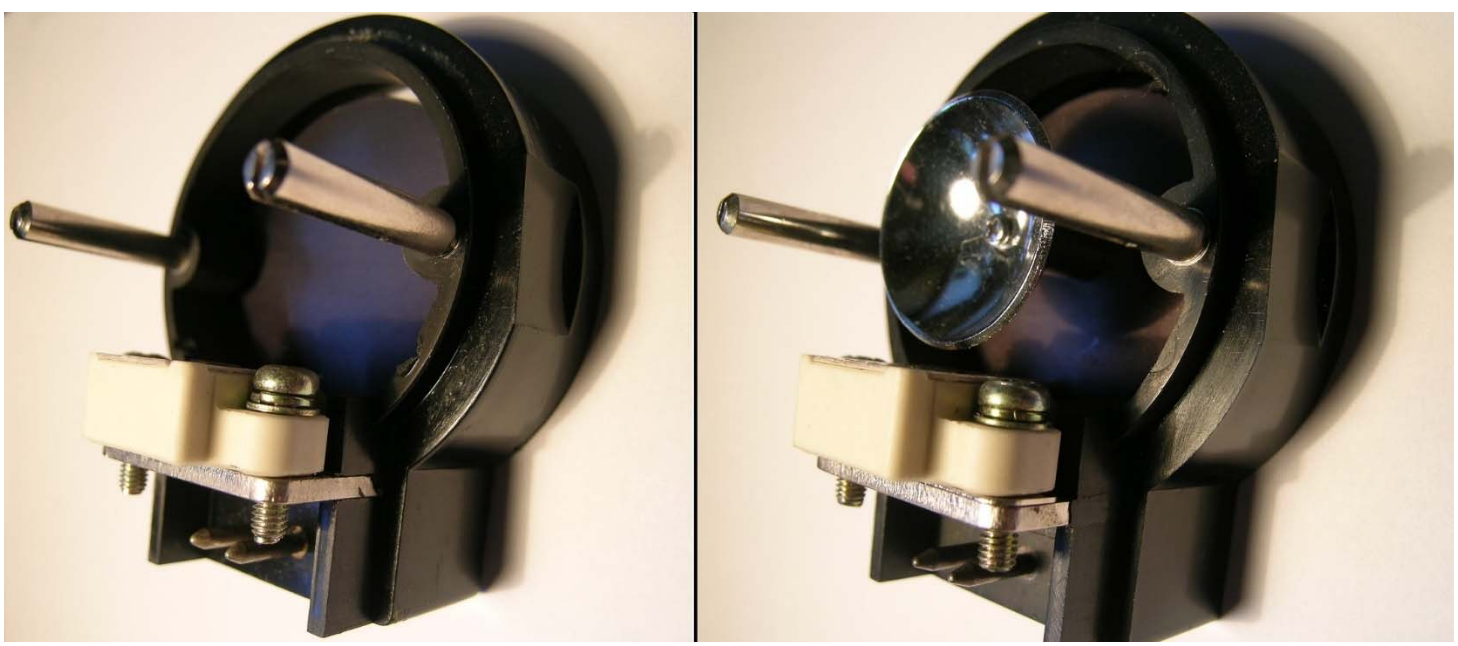


Figure 17 – Original Lamp House (left) and Newer Lamp House with Reflector (right)

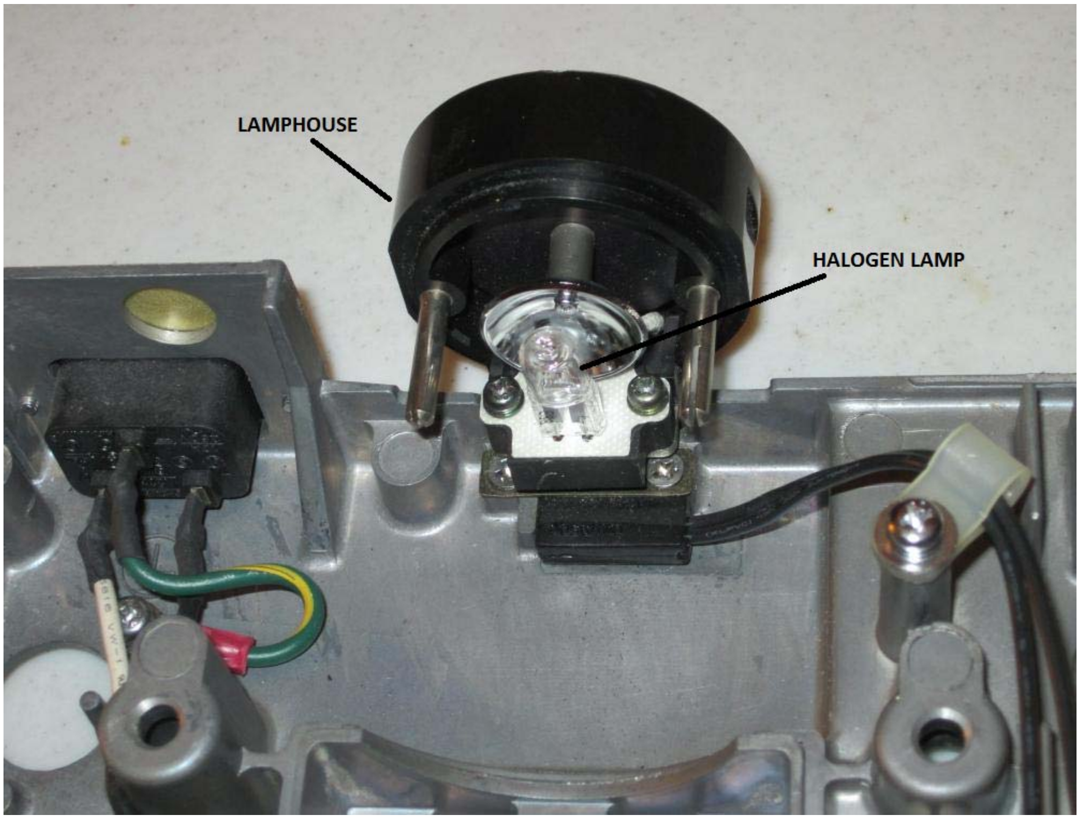


Figure 18 – Lamp House Plugged into BHT/BHTU Electrical Base (100/115V Version)

A repair kit for the Olympus lamp house is available from J.C. Ritchey Company, LLC (see Figure 19). This kit, which includes a replacement for the back cover and a new G4 lamp socket, may be used to overhaul either the LS20H or the LS20H-M2 lamp houses. The replacement back is provided since the original can be damaged during disassembly. The installation of this repair kit requires soldering, but defective lamp houses may be sent to J.C. Ritchey Company for in-house repair/exchange.

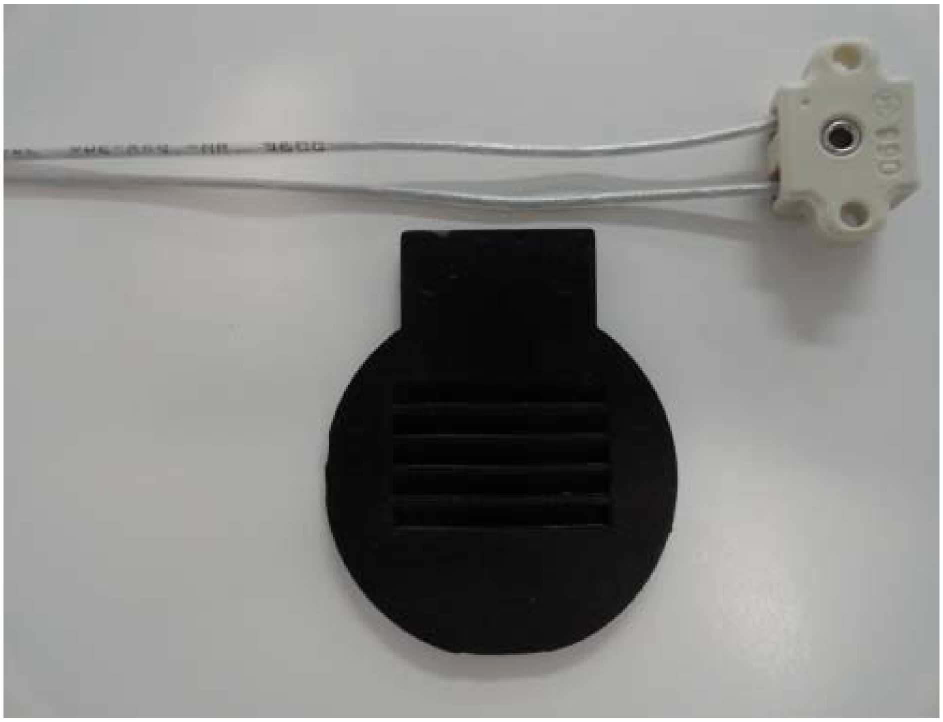


Figure 19 – BHT/BHTU Lamp House Repair Kit from J.C. Ritchey Company (photo courtesy James Ritchey)

Lamp House Repair Procedure[1]

As an alternative to the J.C. Ritchey repair kit, a Bender and Wirth 990 lamp socket (available from J & H Microscope Services or from Bulbworks) may be used to replace the existing lamp socket. To replace the socket with the new Bender & Wirth part, start by removing the halogen lamp and setting it aside, being careful to not touch the glass with your fingers. Next, remove the lamp reflector, if present, by removing the small screw securing the reflector to the support post. Remove the back cover by carefully heating the perimeter of the housing with a heat gun to loosen the adhesive, while pushing from inside the housing, behind the lamp socket, with a screwdriver tip to free the loosened back piece. Avoid direct heat or pressure to the ventilation slots on the back cover, as they are fragile and can be damaged. Once the back cover has been removed, clean off any remaining adhesive and remove the two screws securing the old lamp socket in place. Unsolder the two wires to free the old socket from the housing. Trim and strip the wires on the new socket to match those of the original socket, and solder the new socket in place. Reinstall the two screws to secure the new socket in its proper position. Reinstall the back cover, securing with suitable epoxy, and reinstall the lamp reflector (if applicable). Reinstall the halogen lamp (better still, install a new lamp), being careful to not touch the glass with your fingers. If the glass is accidentally touched, clean it with isopropyl alcohol before use.

Halogen Lamp

The BHT/BHTU stand uses a Philips #7388 halogen projector lamp with a clear quartz envelope and a G4 base (see Figure 20). This lamp, which has a color temperature of 3200K, a color rendering index of 100, and outputs 475 lumens, is rated for 6V/20W with an advertised life of 100 hours at full brightness. The Philips #7388 may be purchased from Bulbworks or Amazon. Alternatively, any of the manufacturer's part numbers listed in Table 1 may be used for replacements as well.

Figure 20 –Philips #7388 FHE/ESB T3 Halogen Projection Lamp

Manufacturer	Part Number
Philips	7388 (256784)
Osram	54261 or 64250 HLX
Ushio	FHE/ESB (1000532)
GE	778 (49718) or 788 (943117)
Nikon	79099
Olympus	8-C405
Reichert	11143
Swift	MA-780

Table 1 – Suitable Halogen Lamps for Olympus BHT/BHTU Microscopes

[1] Lamp house repair procedure courtesy Jerry Clement of J & H Microscope Service, Inc.

Lamp Dimmer Waveforms

All of the waveforms in the following figures are shown relative to the negative output of the bridge rectifier, which is the zero reference point. These waveforms were produced using version 4.19e of the LTSpice IV circuit simulator.

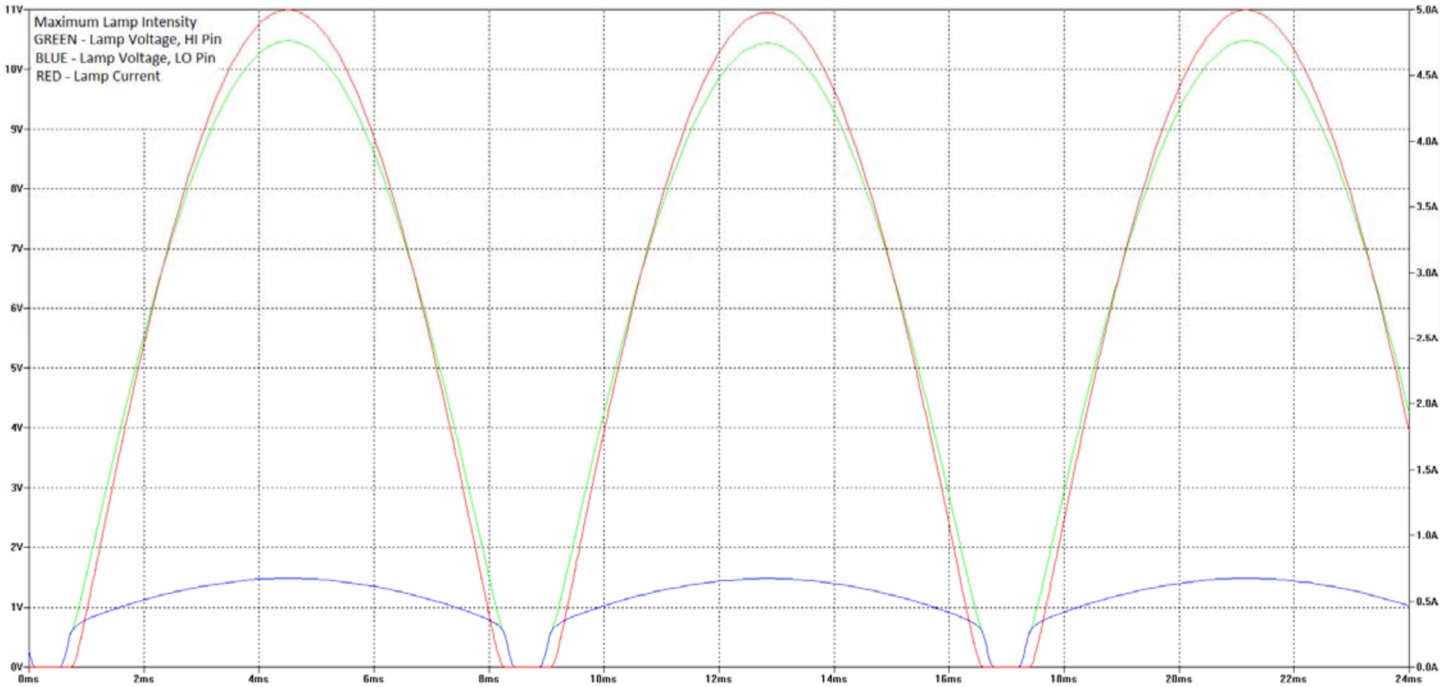


Figure 21 – Lamp Waveforms at Maximum Intensity (100% Setting of Intensity Control)

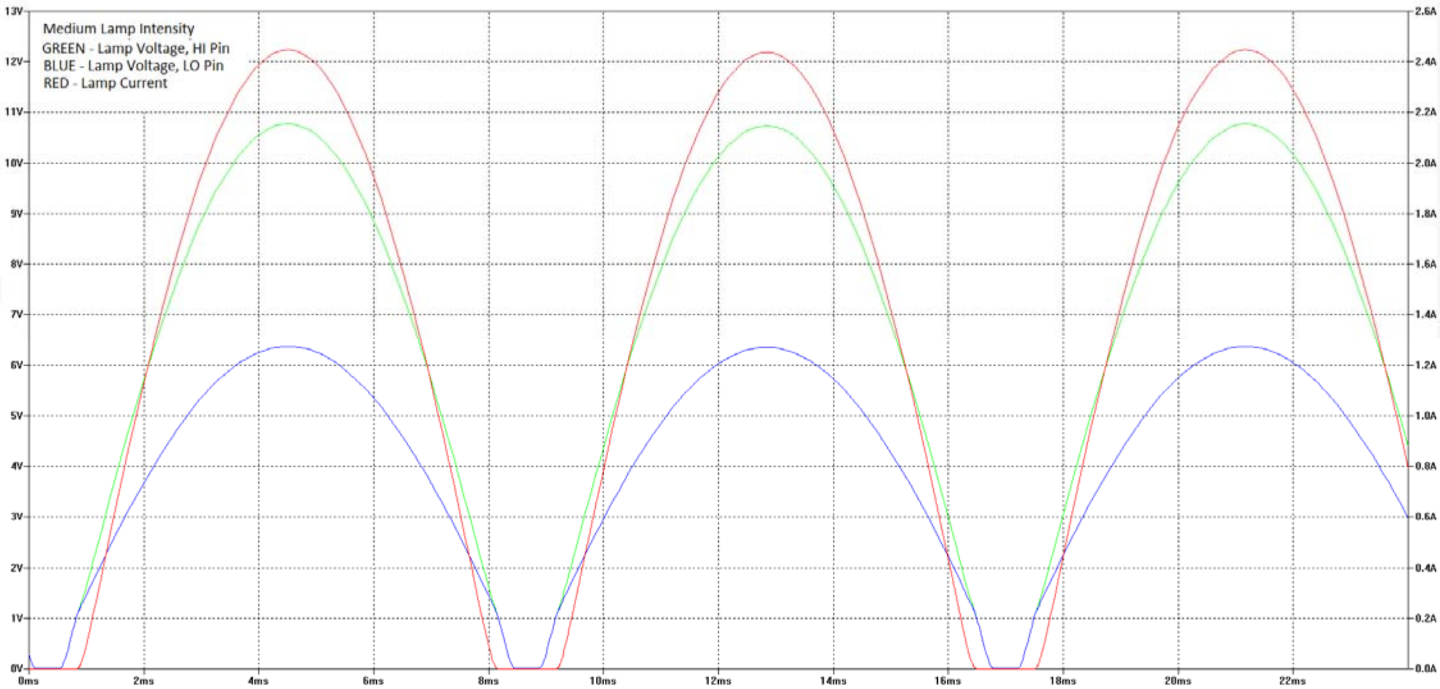


Figure 22 – Lamp Waveforms at Medium Intensity (50% Setting of Intensity Control)

Lamp Dimmer Waveforms (continued)

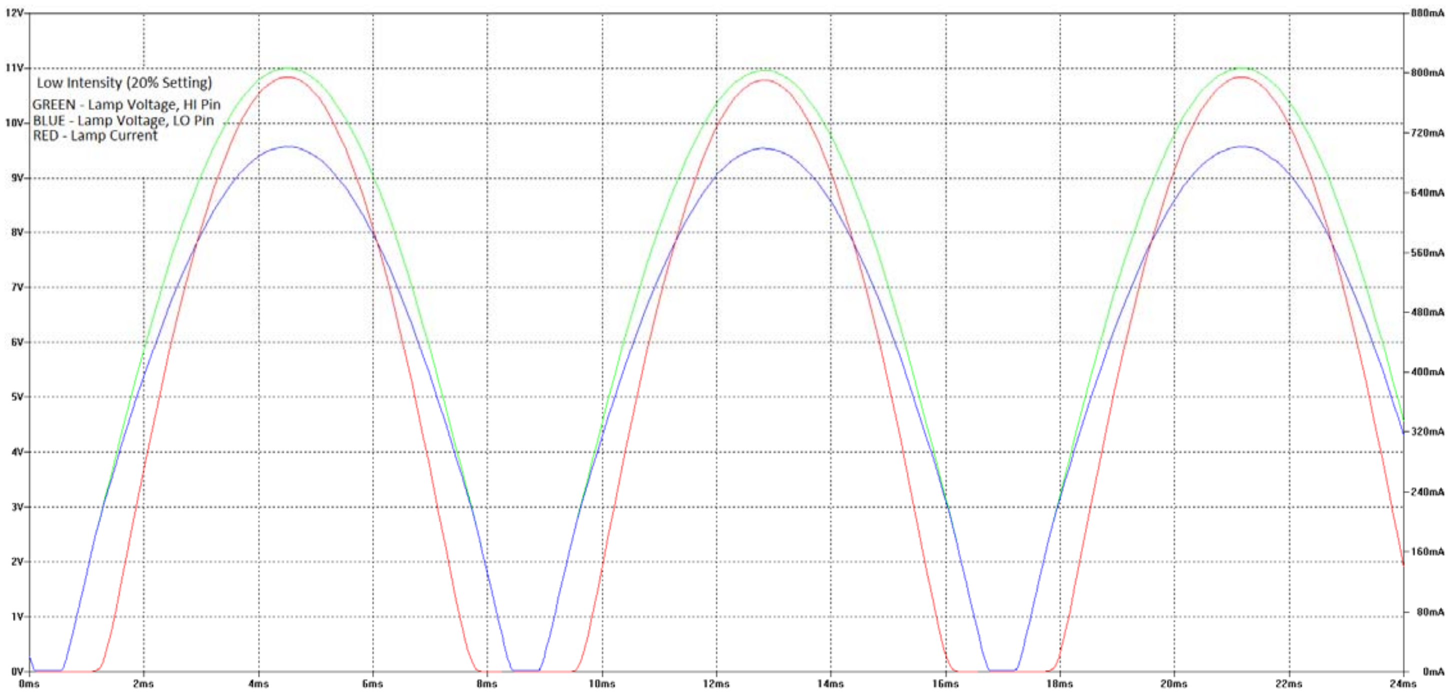


Figure 23 – Lamp Waveforms at Low Intensity (20% Setting of Intensity Control)

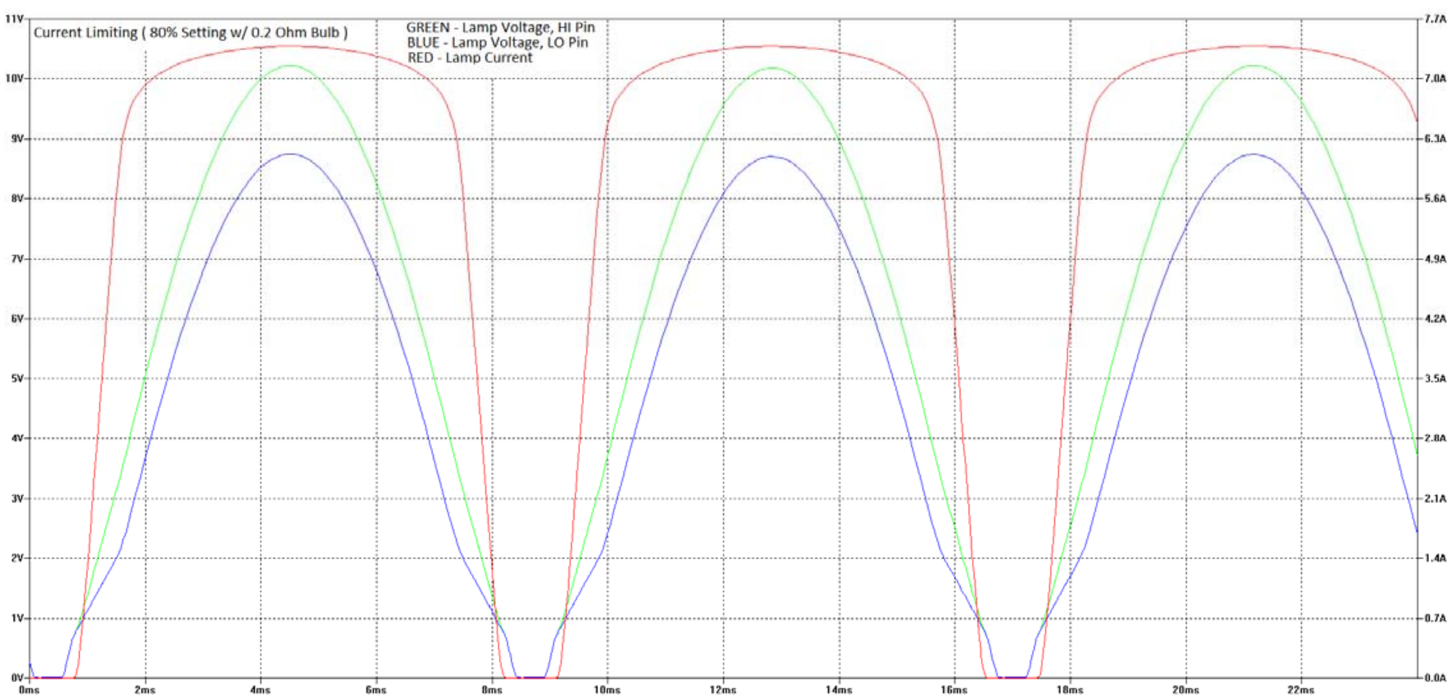


Figure 24 - Lamp Waveforms during Current Limiting (80% Setting of Intensity Control, Lamp Resistance 0.2Ω)

LED Bar-Graph Display Waveforms

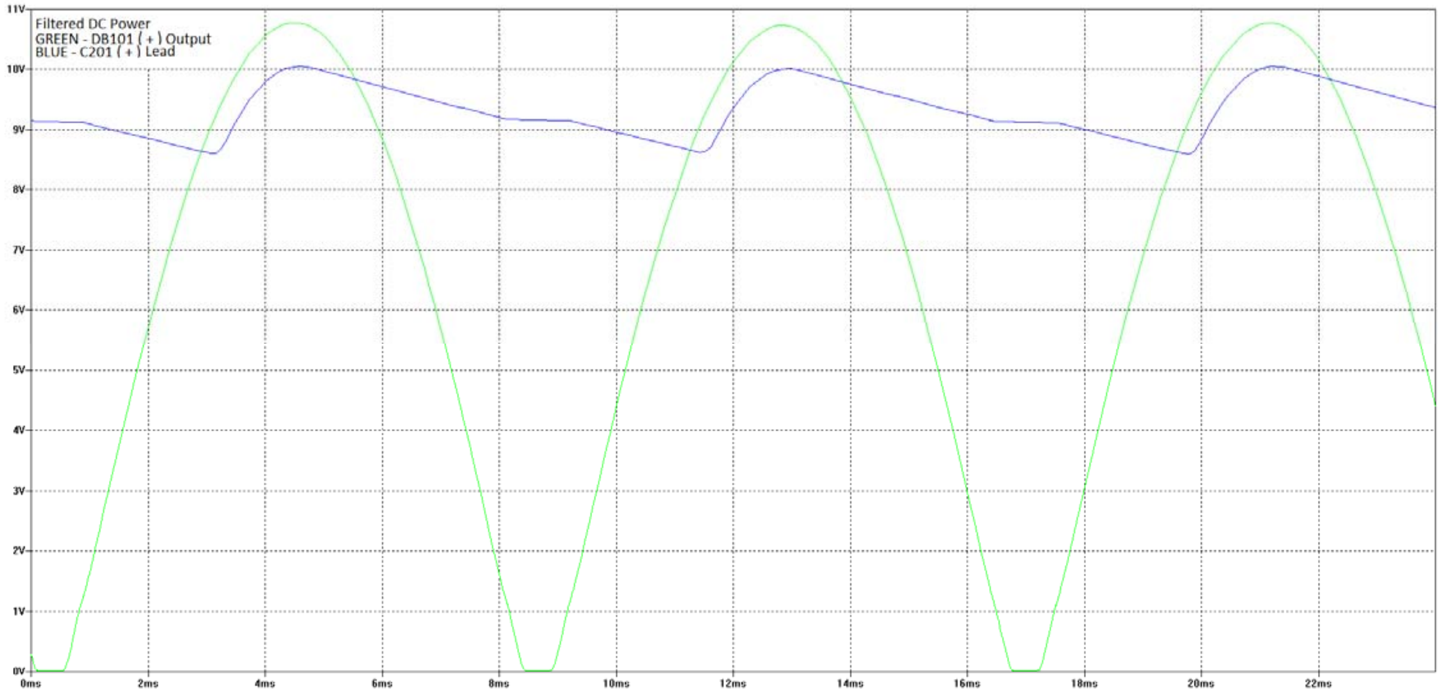


Figure 25 – Filtered DC Power Supply Line at Maximum Lamp Intensity (100% Setting of Intensity Control)

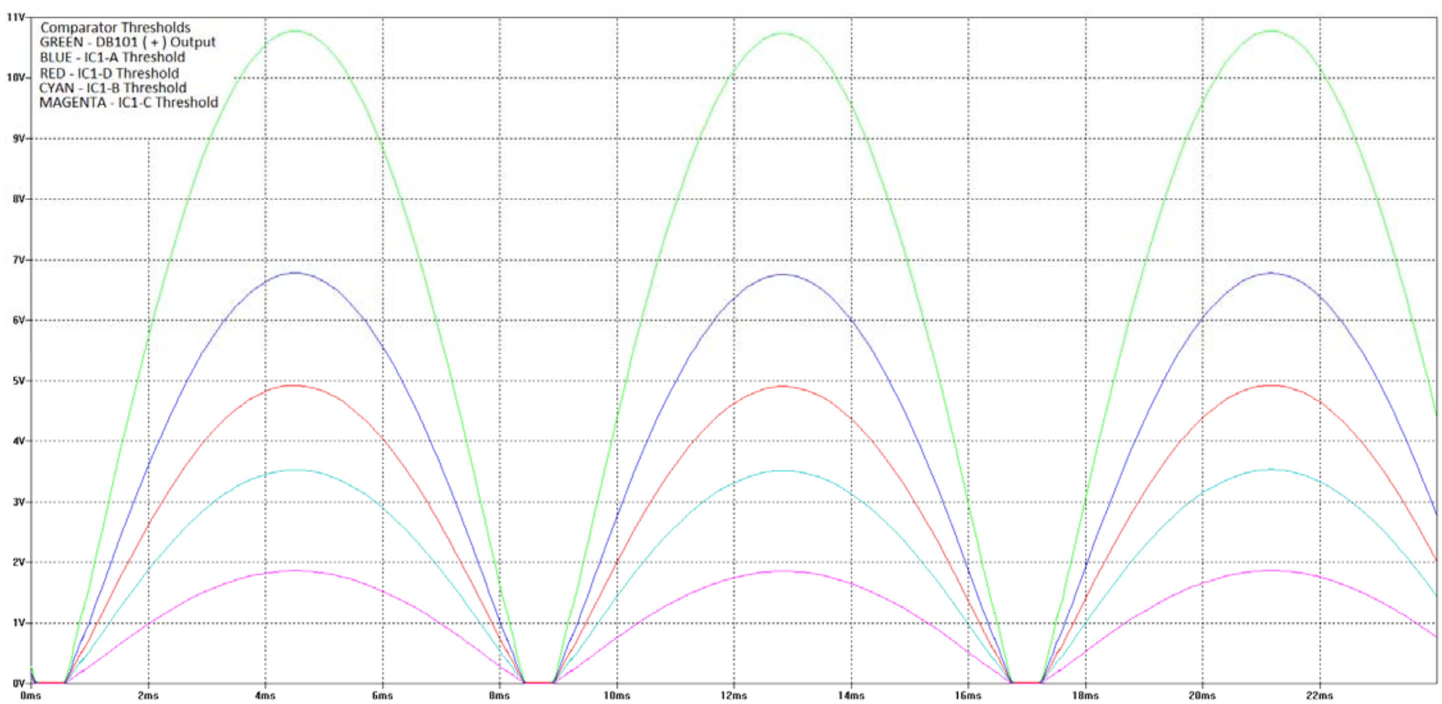


Figure 26 – Bar-Graph Comparator Threshold Voltages

LED Bar-Graph Display Waveforms (continued)

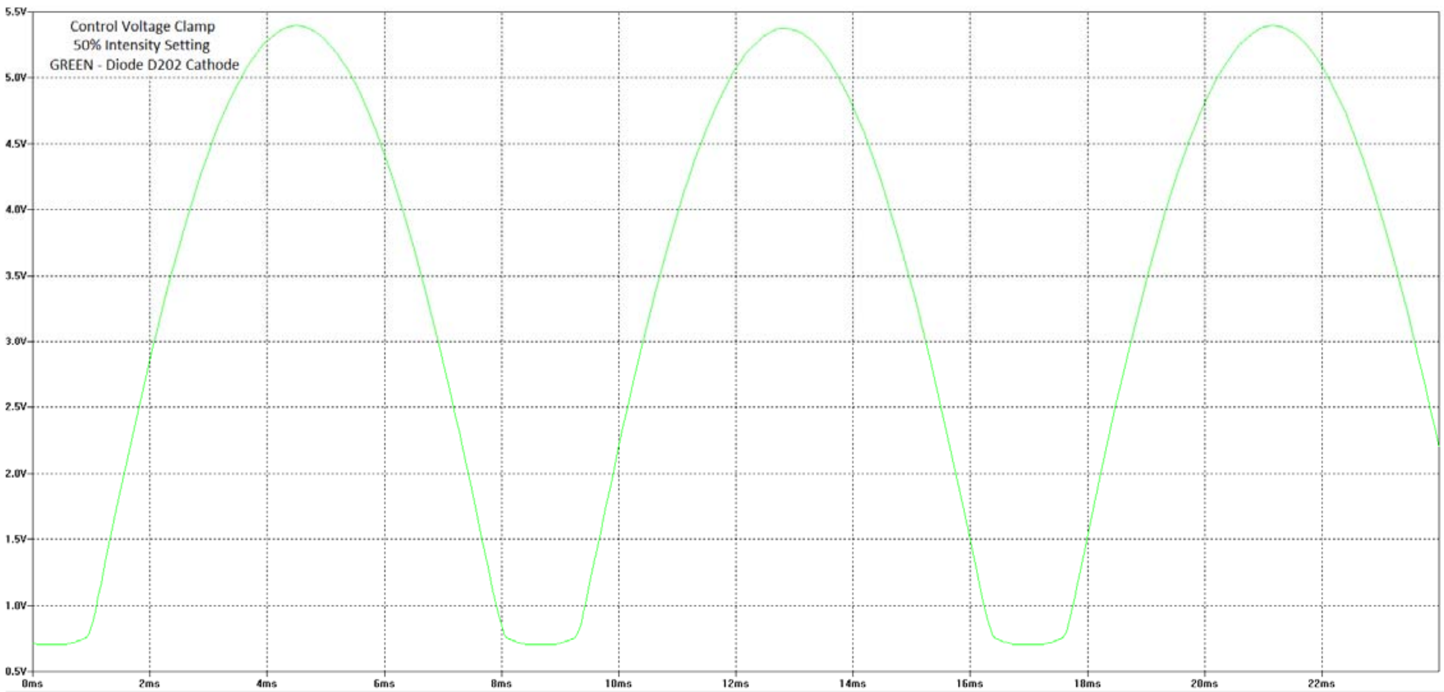


Figure 27 – Clamped Control Signal to Comparators at Medium Lamp Intensity (50% Setting of Intensity Control)

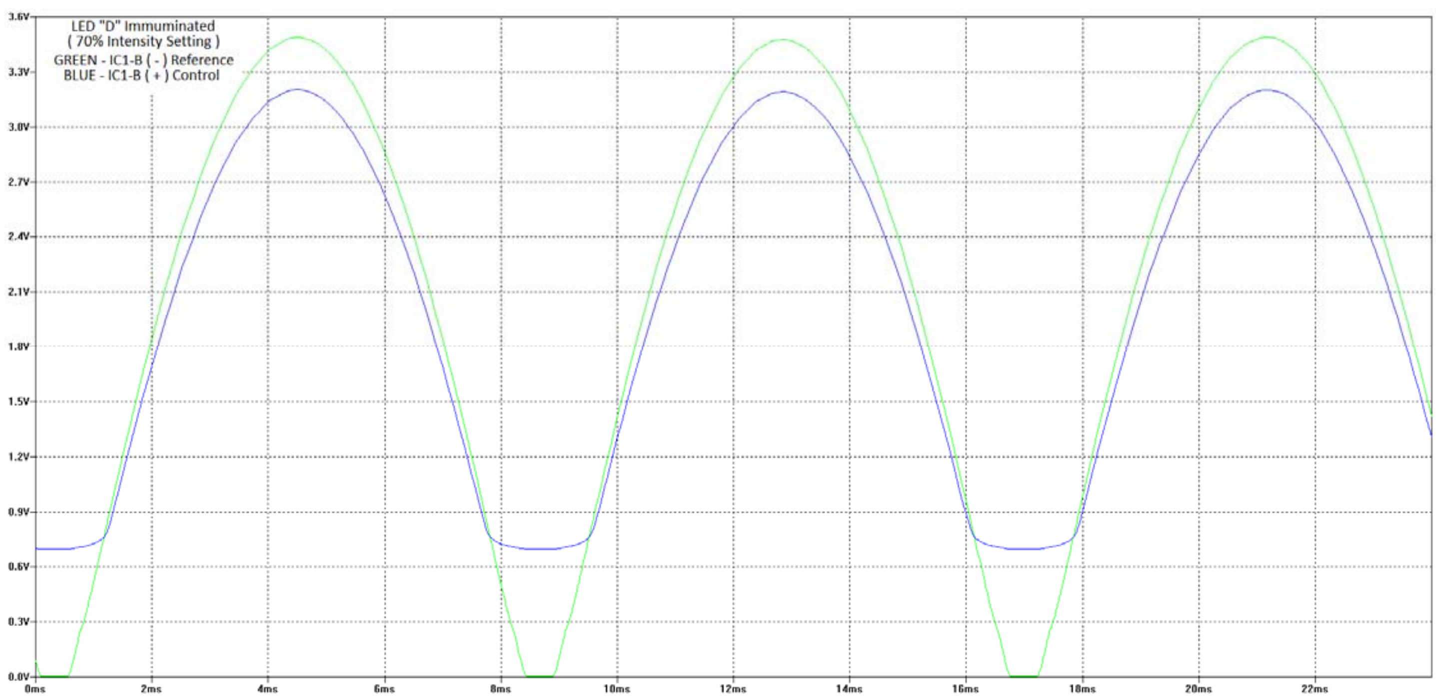


Figure 28 - Comparator IC1-B Inputs with 6V LED Illuminated (70% Setting of Intensity Control)

Appendix 1

Sources for Replacement Parts Referenced in this Document

Listed below are the sources and specific info for the various electronic replacement parts discussed in this document. The pricing listed below is accurate as-of March 2016. Pricing and availability of these parts is subject to change without notice.

Allied Electronics

URL: www.alliedelec.com

NTE36 Silicon NPN transistor	Item #: 70215713	Price: $5.89
NTE5322 Bridge Rectifier, 200V 25A	Item #: 70215808	Price: $4.95

Bulbworks Specialty Lightbulbs and Sockets

URL: www.bulbworks.com
Telephone: 973-584-7171
Email: bulbwork@bulbworks.com

Bender & Wirth 990 ceramic lamp socket	Item #: BW.990	Price: $16.75
Philips #7388 halogen lamp	Item #: BW.ESB	Price: $6.51

Caig Laboratories, Inc.

URL: www.caig.com
Telephone: 858-436-8388

DeoxIT D5 Spray Contact Cleaner	Item #: D5S-6	Price: $18.95

J.C. Ritchey Company, LLC

URL: www.ritcheymicroscopeservice.com
Telephone: 1-740-862-9252
Email: ritcheymicroscopeservice@yahoo.com

Replacement for UYPC48 board w/ power transistor	Item #: JC100	Price: $120
In-house repair/exchange of Olympus lamp house	Item #: JC120	Price: $60
Repair kit for Olympus lamp house	Item #: JC120-1	Price: $30

J & H Microscope Service, Inc.

6 Merrick Ct.
Madison, WI 53704
Telephone: 608-279-3191
Fax: 608-244-4625
Email: madisonwijerry@gmail.com

Bender & Wirth 990 ceramic lamp socket	Item #: Bender & Wirth 990	Price: $10

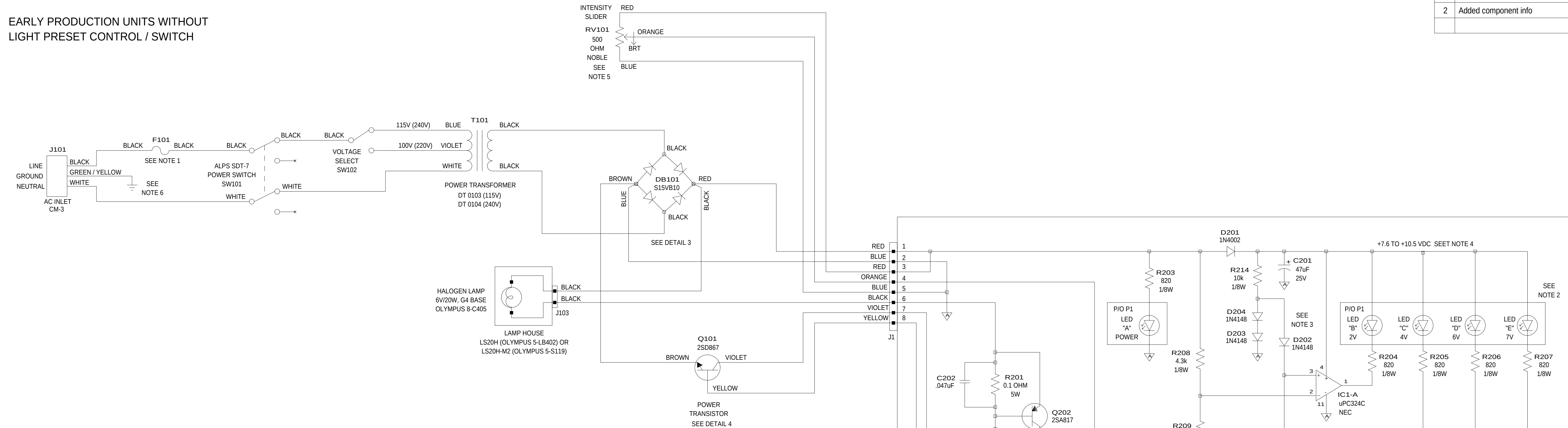
Mouser Electronics

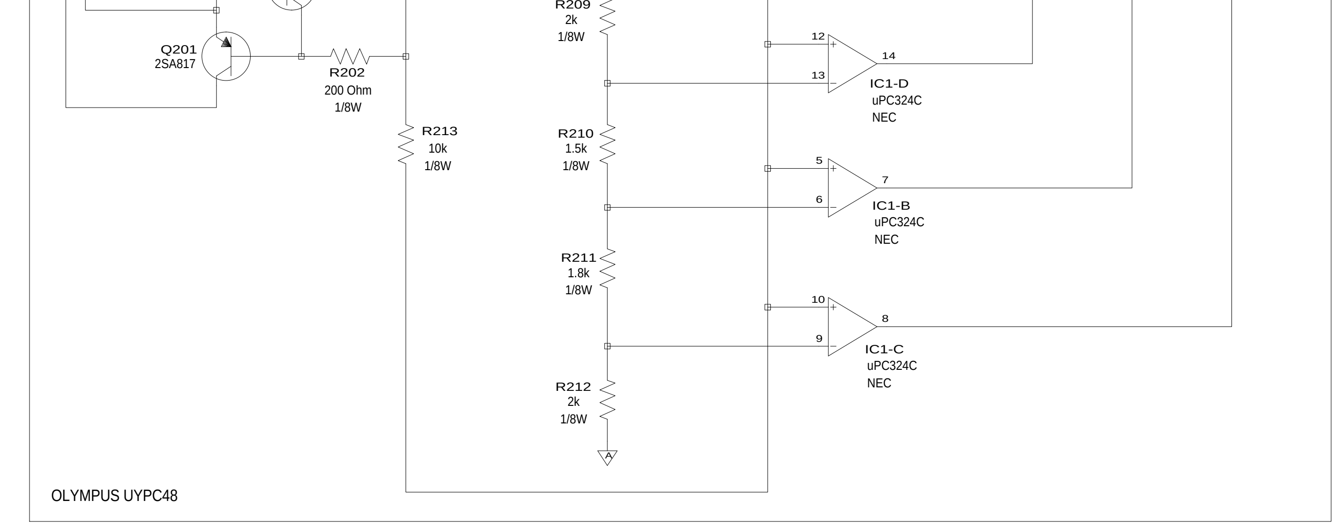
URL: www.mouser.com
Toll Free: 800-346-6873
Email: sales@mouser.com

Vishay 0.1Ω 5W 5% ceramic power resistor	Item #: 71-CP000510R00JE14	Price: $0.34

REV	REVISION DESCRIPTION	DATE	ECO #
1	Initial Release	6-16-14	---
2	Added component info	3-10-16	---

EARLY PRODUCTION UNITS WITHOUT
LIGHT PRESET CONTROL / SWITCH





NOTES:

1- FUSE F101 IS PRESENT ONLY ON THE 240V VERSION OF THE BHTU STAND.

2- THE UYPC48 PCB SCHEMATIC ON PAGE 98 OF THE OLYMPUS BH2(BHS) REPAIR MANUAL DIFFERS FROM THE SCHEMATIC PRESENTED HERE IN THE WIRING OF THE BAR-GRAPH LEDS AND THEIR CURRENT-LIMITING RESISTORS. SEE DETAIL 1.

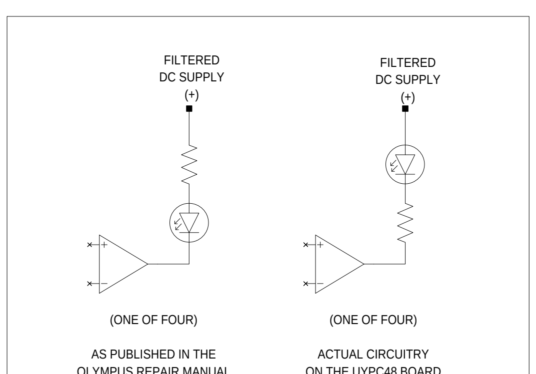
3- THE UYPC48 PCB SCHEMATIC ON PAGE 98 OF THE OLYMPUS BH2(BHS) REPAIR MANUAL DIFFERS FROM THE SCHEMATIC PRESENTED HERE IN THE WIRING OF THE CONTROL VOLTAGE CLAMP. SEE DETAIL 2.

4- THE AVERAGE DC VOLTAGE ON THIS NODE VARIES FROM APPROXIMATELY +10.5V (AT MINIMUM LAMP VOLTAGE) TO +7.6V (AT MAXIMUM LAMP VOLTAGE), DUE TO INCREASED RIPPLE AT HIGHER CURRENT DRAINS.

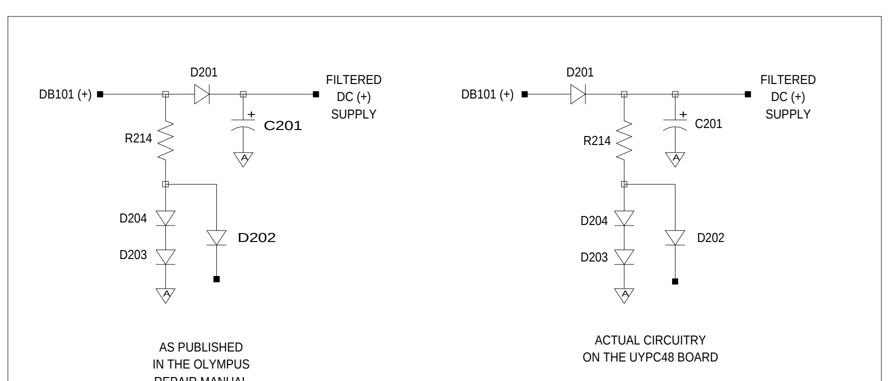
5- SEE APPENDIX 3 FOR LATER PRODUCTION UNITS THAT INCLUDE THE LIGHT PRESET CONTROL / SWITCH.

6- NEVER OPERATE THE MICROSCOPE WITHOUT THE CENTER TERMINAL OF THE AC INLET ELECTRICALLY BONDED TO THE CHASSIS.

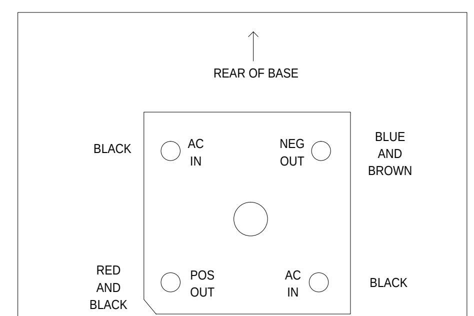
7- W201, W202, W203, AND W204 (NOT SHOWN IN THE SCHEMATIC) ARE ZERO-OHM CIRCUIT JUMPERS INCLUDED TO ALLOW A SINGLE LAYER PCB. THESE COMPONENTS ARE PRESENT ON EARLY PCBS ONLY.



- DETAIL 1 -
DISCREPANCY WITH OLYMPUS SCHEMATIC
- BAR-GRAPH LEDS -
SEE NOTE 2

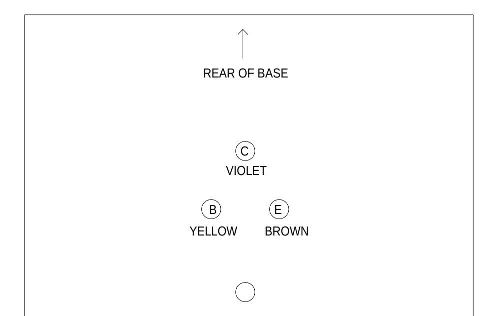


- DETAIL 2 -
DISCREPANCY WITH OLYMPUS SCHEMATIC
- CONTROL-SIGNAL CLAMP -
SEE NOTE 3



- DETAIL 3 -
PINOUT OF BRIDGE
RECTIFIER DB101

-INSTALL WITH THERMAL PASTE-
(VIEW FROM TOP OF BASE)



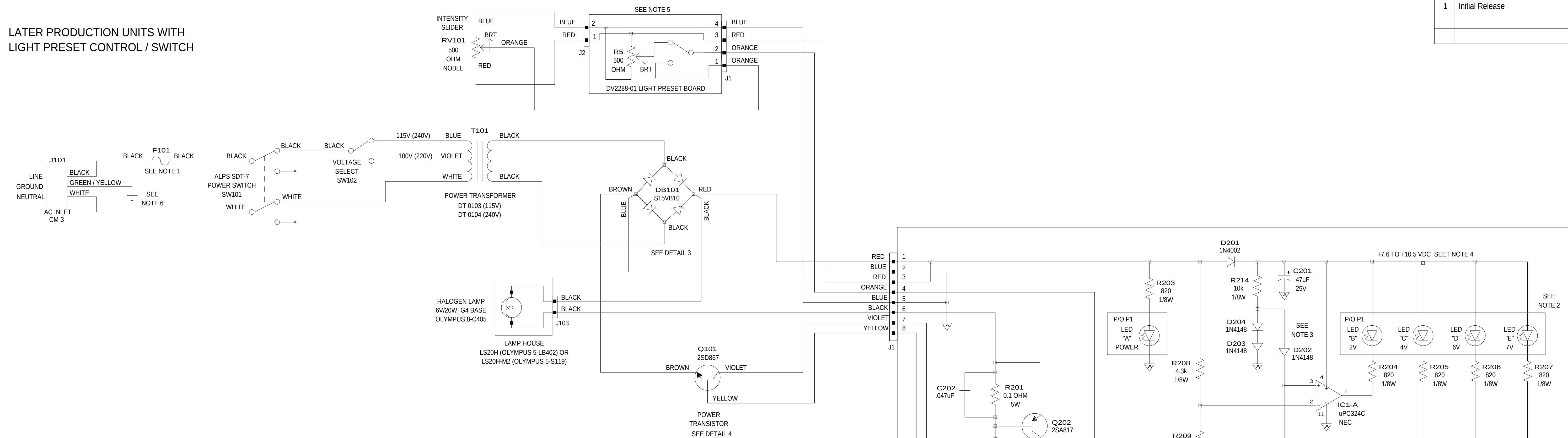
- DETAIL 4 -
PINOUT OF POWER
TRANSISTOR Q101

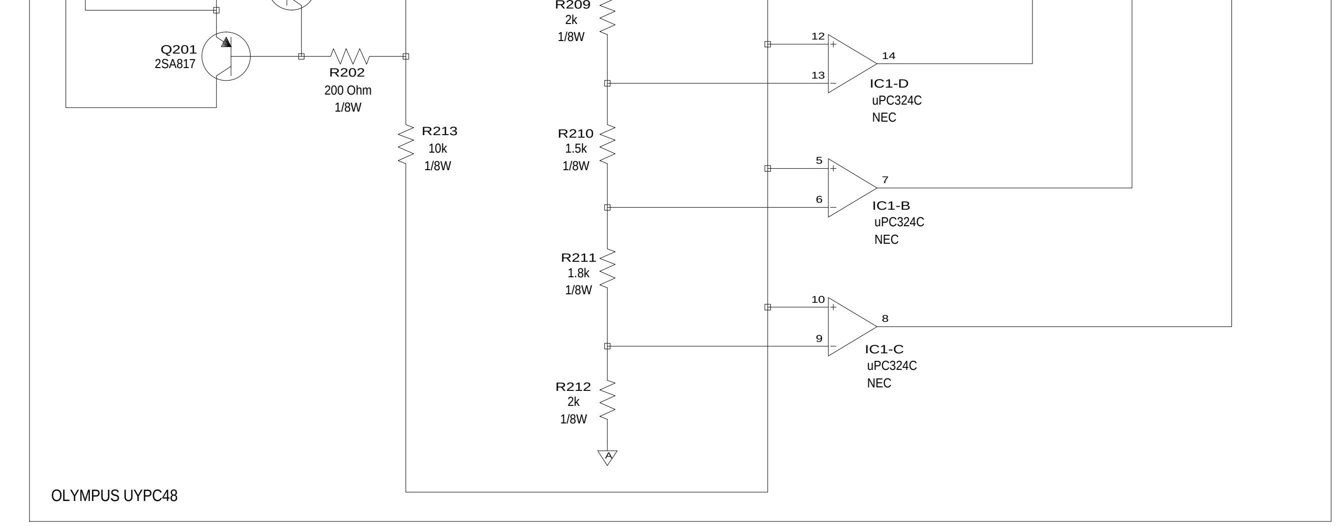
-INSTALL WITH THERMAL PASTE-
(VIEW FROM TOP OF BASE)

- APPENDIX 2 -
OLYMPUS BH-2 (EARLIER)
BHT/BHTU ELECTRONICS
REVISION 2

REV	REVISION DESCRIPTION	DATE	ECO #
1	Initial Release	3-10-16	---

LATER PRODUCTION UNITS WITH
LIGHT PRESET CONTROL / SWITCH





NOTES:

1- FUSE F101 IS PRESENT ONLY ON THE 240V VERSION OF THE BHTU STAND.

2- THE UYPC48 PCB SCHEMATIC ON PAGE 98 OF THE OLYMPUS BH2(BHS) REPAIR MANUAL DIFFERS FROM THE SCHEMATIC PRESENTED HERE IN THE WIRING OF THE BAR-GRAPH LEDS AND THEIR CURRENT-LIMITING RESISTORS. SEE DETAIL 1.

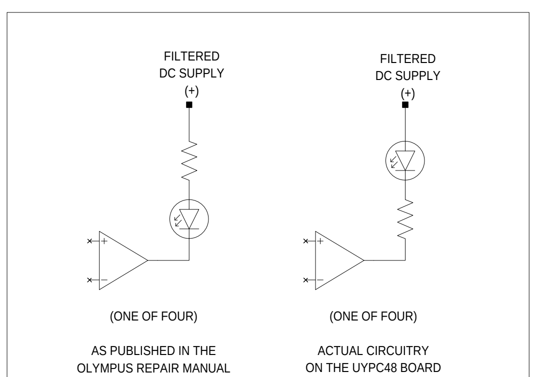
3- THE UYPC48 PCB SCHEMATIC ON PAGE 98 OF THE OLYMPUS BH2(BHS) REPAIR MANUAL DIFFERS FROM THE SCHEMATIC PRESENTED HERE IN THE WIRING OF THE CONTROL VOLTAGE CLAMP. SEE DETAIL 2.

4- THE AVERAGE DC VOLTAGE ON THIS NODE VARIES FROM APPROXIMATELY +10.5V (AT MINIMUM LAMP VOLTAGE) TO +7.6V (AT MAXIMUM LAMP VOLTAGE), DUE TO INCREASED RIPPLE AT HIGHER CURRENT DRAINS.

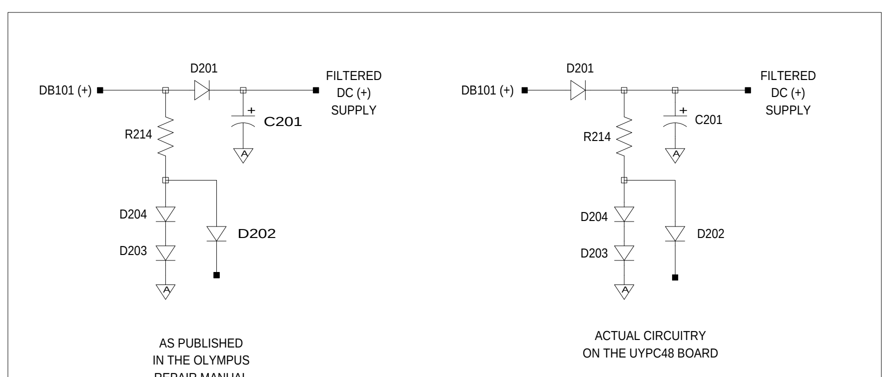
5- SEE APPENDIX 2 FOR EARLY PRODUCTION UNITS THAT DO NOT HAVE A LIGHT PRESET CONTROL / SWITCH.

6- NEVER OPERATE THE MICROSCOPE WITHOUT THE CENTER TERMINAL OF THE AC INLET ELECTRICALLY BONDED TO THE CHASSIS.

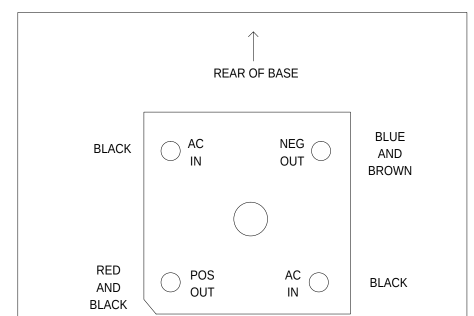
7- W201, W202, W203, AND W204 (NOT SHOWN IN THE SCHEMATIC) ARE ZERO-OHM CIRCUIT JUMPERS INCLUDED TO ALLOW A SINGLE LAYER PCB. THESE COMPONENTS ARE PRESENT ON EARLY PCBS ONLY.



- DETAIL 1 -
DISCREPANCY WITH OLYMPUS SCHEMATIC
- BAR-GRAPH LEDS -
SEE NOTE 2

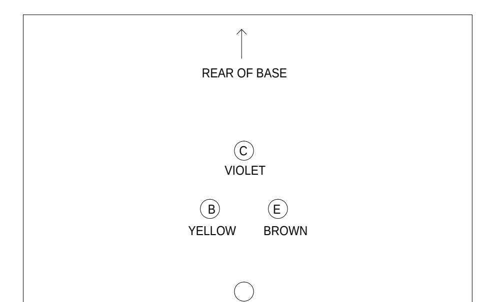


- DETAIL 2 -
DISCREPANCY WITH OLYMPUS SCHEMATIC
- CONTROL-SIGNAL CLAMP -
SEE NOTE 3



- DETAIL 3 -
PINOUT OF BRIDGE
RECTIFIER DB101

-INSTALL WITH THERMAL PASTE-
(VIEW FROM TOP OF BASE)



- DETAIL 4 -
PINOUT OF POWER
TRANSISTOR Q101

-INSTALL WITH THERMAL PASTE-
(VIEW FROM TOP OF BASE)

- APPENDIX 3 -
OLYMPUS BH-2 (LATER)
BHT/BHTU ELECTRONICS
REVISION 1