

Illuminated Stage Version III

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Introduction

This article is a follow up to a previous article that discussed the construction of two illuminated stages specifically intended for use with a USB Microscope. The lessons learned from those designs have been applied to build this lower cost, and more effective design. See:

<http://www.msweb.org/public/articles/AnIlluminatedStage.pdf>

There are two primary differences in the requirements for a USB microscope illuminated stage compared to normal microscope use. The first is a larger working area because the magnification¹ is usually limited to the range of 1x to 20x with most low cost USB models. The second requirement is a fine control of the light output because the USB video camera uses automatic electronic focus and light level adjustment and you are trying to get that “just right” balance for the optimum captured image. This also means that the light brightness does not have to be as bright as would be required for much higher magnification and that the light level must be adjustable to be reduced to a barely perceptible/zero brightness.

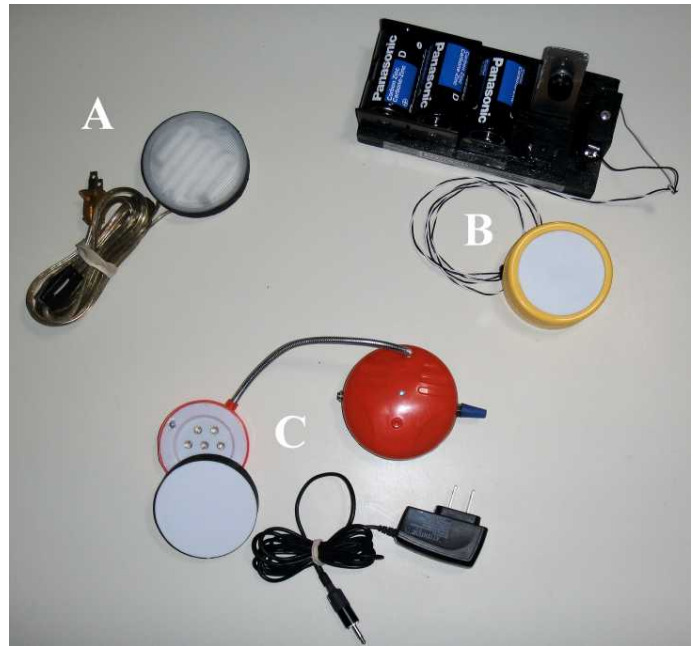


Fig. 1 – Three USB microscope illuminated stages.

Fig. 1 shows the new design, “C” with the previously described homemade designs. These are:

- A. AC operated fluorescent lamp design shown without diffuser. This design is described in detail in the article at the link above and is an on-off design that does not provide variable brightness. It uses 9 watts of AC power and gets quite warm.
- B. DC, battery, operated variable brightness design with built-in diffuser. This design is very cool and may easily be altered to be very bright if needed because of the 63 LEDs that are used. Battery life, however, would be reduced.
- C. New design inspired by the previous designs. It is low cost, battery or AC operated, and has a variable brightness range most suitable for USB microscope use.

1. *Magnification is defined differently when the image is shown on a computer screen. While not exactly correct, the magnification as used by USB microscope manufacturers is the ratio of the screen image to the object being shown. This is discussed in an associated article at: <http://www.msweb.org/public/articles/MicroscopeMagnification.pdf> The result of this difference is the highly inflated magnification numbers used by USM microscope manufacturers. Divide the USB microscope manufacturer’s number by at least 10 to get a more realistic idea of the true magnification. These inflated numbers refer to empty magnification as defined and measured in the article at the link above.*

Illuminated Stage III Details

The illuminated stage shown in Fig. 1 “C” consists of three parts; a standard \$1 Portable LED Lamp that has been modified, a homemade \$1 diffuser, and a \$1 AC adapter.

It should be mentioned that any specific parts shown here are for ideas only. Because of modern outsourced manufacturing, and retail marketing practices, products change quickly and by the time you read this article the specific product or part will most likely not be available in the version as shown here.

The lamp is a 99 Cent Only store item. It has a very nice flexible six inch arm that supports a seven white LED head. The required three AA cells are not included. There is enough space in the base to add a small potentiometer, power jack, and power on indicator. Fig 2 and Fig. 3 show the details of the unmodified lamp and diffuser. Fig 5 and Fig. 6 show the LED light output at two light levels, low and medium. The LEDs are not exactly the same in brightness and this is typical. The diffuser spreads this light over the full 2.4 inch lit diameter area.

The diffuser is constructed from a ½ inch length cut from a 91¢ 2 inch PVC pipe coupling. Then two diffuser circles are cut from the cover of a \$1 Big Lot Sterilite 6 Qt. plastic container. The cover will provide material for three diffusers. The coupling will also provide enough material for more than three diffusers so the total materials cost of the diffuser is less than \$1. Most glues/adhesives will work to attach the two diffuser discs to the PVC pipe ring. I used Kwik Seal Plus Kitchen & Bath Adhesive Caulk. The outside edge is cosmetically covered with a strip of black paper. See Fig. 4 and Fig. 7.



Fig. 2 – Battery, 3x AA, powered Lamp and diffuser.

Fig. 3 – 7 LED's.

Fig. 4 – Diffuser on lamp head.

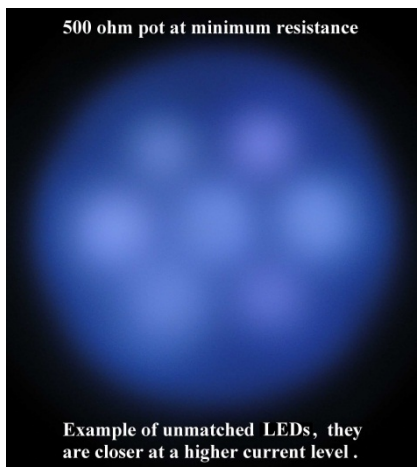


Fig. 5 – LED's are not uniform.

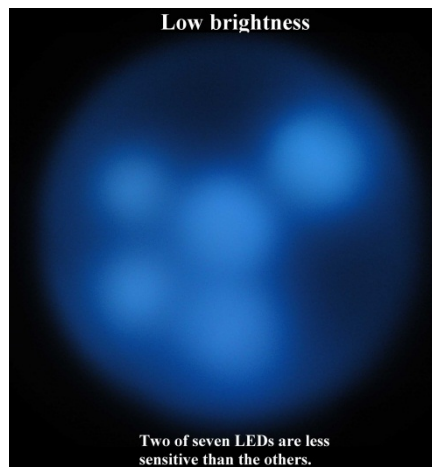


Fig. 6 – Low output 2 of 7.



Fig. 7 – Diffuser specifications.

The AC adapter was a challenge in terms of keeping the total cost to a minimum. Internet suppliers like All Electronics offer a wide range of adapters in the \$3 to \$6 price range. A small size regulated 5.1 volt DC output was desirable with a current capability of at least 700 mA. A surprising source of this little gem was Goodwill Industries. We have several of these stores in the Mesa AZ area, but I haven't been impressed with their prices for the used donated items. They have, however, an interesting sale policy.

Good Will uses multiple colored price tags. Each week has a color of the week and the price is half if the item you want has a color of the week price tag. Additionally, for the last day of the week (Thursday locally) the item sells for just one dollar. I checked the "electronics" department of several stores and they had switching cell phone chargers (power supplies) with a \$2 blue price tag. The color of the week was blue. I bought two, one from each store. Check the specifications molded in the plastic housing for the DC output voltage and current specifications. Cut off the special phone plug at the end and solder on your own plug. There are only two wires. I made a 24 hour full load test and it ran very cool and it was well regulated at full to light loading. Most "cheap" AC wall adapters are unregulated and a 12 VDC, 200mA output will often be 20 - 21 volts at no load. The cell phone adapter was 5.1 ± 0.1 volts (or less than ± 0.1 volts) from no load to full load. This is much better and the input voltage may range from 100 to 240 VAC. My cost was \$ 0.99 "on half-price sale."

Fig. 8 – shows the modified illuminated stage with each part identified. The LEDs are operated at twice the current when the AC adapter is plugged in - 500 mA vs. 230 mA when battery operated.

Circuit Schematic

Fig. 9 shows the electrical circuit of the modified Portable LED Lamp with the added power indicator (D1 & R3), R3 is required to limit the current to a very low level for the on/off indicator LED D1; AC Adapter phone jack (J1); and 500 ohm Brightness Control potentiometer (R4). Resistor R1 was originally 5.6Ω and it has been replaced with two resistors, R1 & R2. LEDs D2 through D8 are original and mounted in the lamp head.

J1 is a standard switched 1/8" miniature phone jack. It was

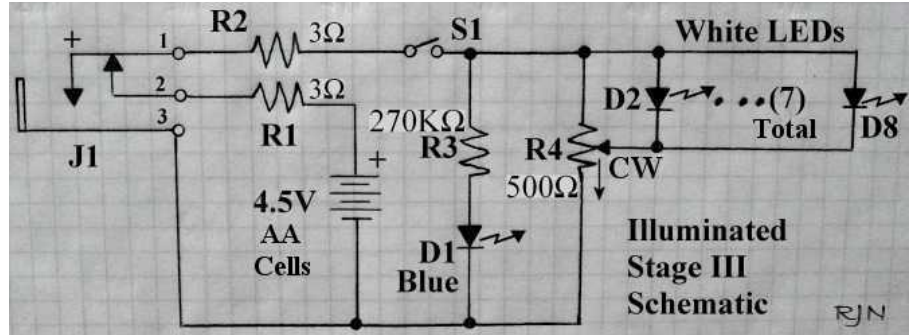
purchased at Radio shack and is the most expensive component in the circuit. The tip is positive as indicated, and when it is plugged into J1 it raises the contact breaking the circuit at J1 terminals 1 & 2. Power is then supplied to the LED head through S1. The voltage applied to the white LEDs is from the potentiometer R4, and the voltage increases with clockwise rotation as indicted in the schematic.



Fig. 8 – Illuminated Stage III component identifications.

If the AC Adapter is not plugged in the white LED array current is limited by the two three ohm resistors in series. This current is about 230 mA. When the AC adapter is plugged in only one of the three ohm resistors limits the current to about 500 ma. This allows the LEDs to be brighter when operated on AC.

Using a switched J1 in this way provides an automatic light level adjustment which is desirable if the illuminated stage is used with a



conventional microscope which is *Fig. 9 – Schematic diagram. See text for details.*

always seems a bit short on light. Appendix A provides a detailed parts list. Fig. 10 shows the illuminated stage in use with a Stereo microscope.

Observations and Conclusions

The performance of two previously described illuminated stages didn't provide all of the desirable features of AC and battery operation, variable light intensity, cool operation, and low cost.

Starting with a \$1 Portable LED Lamp a diffuser was added based on the experience gained in building the first two designs. A low cost AC adapter was found to provide suitable power and an automatic increased light is provided by using a switched power jack.



Fig. 10 – Illuminated Stage III being used with a stereo microscope.

Aside from the normal flimsy construction of very cheap products the primary flaw in the design is the exposed tip of the miniature phone plug. **You must be careful to avoid having the AC Adapter plugged in when it is not plugged into the base of Portable LED Lamp.** If the exposed plug touches a metal object across the two terminals it may be shorted and cause damage to the AC Adapter. Appendix A provides a detailed parts list with a total cost of \$9.19. Add a few dollars for shipping, etc. and this could be called the \$15 Dollar Illuminated (USB) Microscope Stage.

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Appendix A – Illuminated Stage III Parts List

Portable LED Lamp – See Fig. A1 below.

#	Item	Description	Number (UPC etc.)	Source	≈ Cost
1	Portable LED Lamp	To be modified	2 22052 10708 1, TW-X05	99 Cent Only	\$ 0.99 ea.
2	AA Cell, alkaline	Kirkland, 3 required	0 96619 22738 1, 227380	COSTCO	\$ 0.23 ea.
3	R1 ¹ , R2 ¹	3Ω, ½ W, 5% Resistor, 2 ea.	NA	Circuit Specialists	\$ 0.07 ea.
4	R3 ¹	270 KΩ, ½ W, 5% Res.	NA	Circuit Specialists	\$ 0.07 ea.
5	R4 ¹	500 Ω, Lin Pot	LTP-500	All Electronics	\$ 0.75 ea.
6	Pot Knob	Wire Nut	NA	Junk box.	—
7	D1 ¹	Blue LED	139B	All Electronics	\$0.50 ea.
8	S1	Part of #1	—	—	—
9	J1	1/8" Phone Jack, 2 per pkg.	274-0248	Radio Shack	\$ 1.65
Total:					\$ 4.79

Notes: 1. Internet purchased (hook up wire, solder, and heat shrink tubing are not listed.)

Diffuser - Multiuse

#	Item	Description	Number	Source	≈ Cost
1	Ring	Coupling, 2" PCV, Sch 40	429-020	Home Depot	\$ 0.91
2	Diffuser material	White, 1642	0 73149 16428 6	Big Lots	\$ 1.00
3	Adhesive, small dab.	Kwik Seal Plus Kitchen & Bath Adhesive Caulk	0 70798 18546 2	Junk box, Home Depot	—
4	Outside covering	Black paper, 20# bond	?	Junk box	—
Total:					\$ 1.91

AC Adapter

#	Item	Description	Number	Source	≈ Cost
1	Adapter	Cell Phone Charger	NA	Goodwill Industries	\$ 0.99 ea.
2	Plug	1/8" Phone Plug, 2 per pkg.	274-0286	Radio Shack	\$ 1.50 ea.
Total:					\$ 2.49

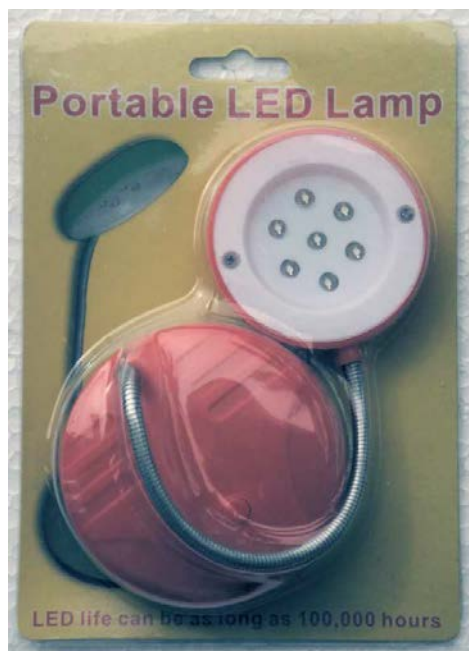


Fig. A1a – Front of product card.

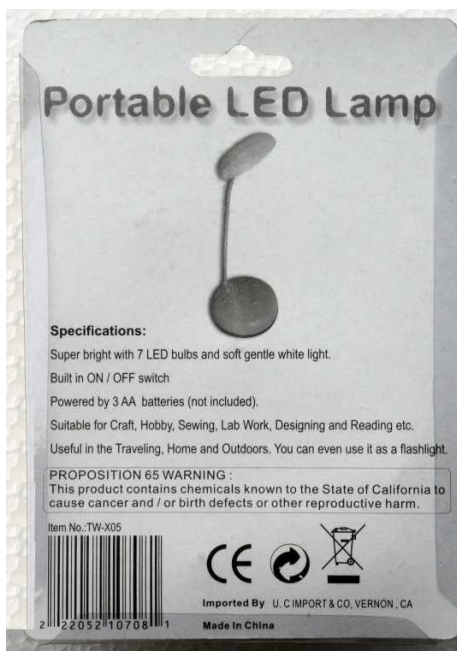


Fig. A1b – Back of product card.