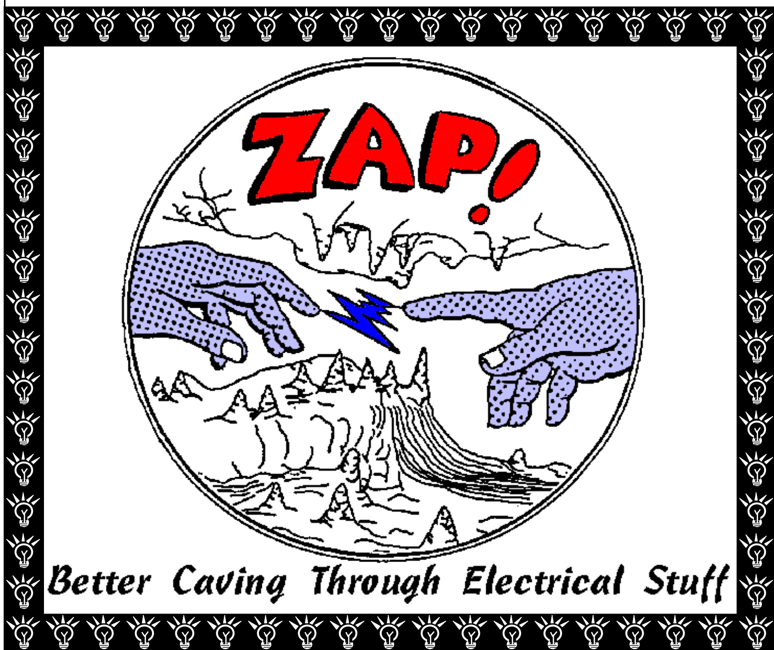
SPELEONICS 22

COMMUNICATIONS AND ELECTRONICS SECTION OF THE NATIONAL SPELEOLOGICAL SOCIETY



The Section logo from *SPELEONICS* 1 was updated in *SPELEONICS* 10. It was further embellished with color for the Section web pages during 1999 and now for *SPELEONICS* 22.

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Foreign subscriptions can be paid in U.S. "paper" dollars in the mail; an international money-order may cost as much as the subscription itself. Many members have sent cash without problems (NO foreign currency, please).

Editorship rotates among the officers. Volunteers are encouraged to guest-edit or produce an issue. A technical session, followed by election of officers, is held annually during the NSS Convention.

Complimentary copies of ***SPELEONICS*** go to NSS offices and sections, the U.S. Bureau of Mines, U.S. Geological Survey, and the Longwave Club of America.

Contributions of articles for publication from members is highly encouraged.

Contents of *SPELEONICS* 22 Volume VI #2

Message from the Editor

Publish or Perish: The Communications and Electronics Section has been without a newsletter for over four years (March 1997). "Speleotardiness" it was called then. The issue previous to that one was three years before (February 1994). During this time there have been some great advances in technology that affect caving and cavers. We, as a group, have suffered by not having OUR newsletter, ***SPELEONICS***, published. During this time, it appears that some of our membership, with their knowledge and drive, have drifted away. An organizational publication is the glue that binds the members together. There are a multitude of reasons for not having a proper publishing schedule, not the least of which was the death of Frank Reid - one of the founders and long time proponents of the Section.

We are moving on with this issue to keep from withering on the vine. If I have anything to do with it, we will soon have more ***SPELEONICS*** issues, in electronic format, to share the ideas and projects that caving community has to offer. Please support YOUR section by writing up some of the electronic projects that you are involved with.

The Section Web Site: The C&E section website is alive and well, thanks to Gary Bush. There are some past ***SPELEONICS*** articles, as well as the index of the previous issues. Information and news will be updated there when it becomes available. Point your web browser to: http://www.caves.org/section/commelect/

Issue #22 is heavy with lighting articles. This subject is kind of like publishing the newsletter - Light IS Life. I hope that you enjoy this issue and will give back to the Section by writing a future article. It doesn't have to be about LED caplamps... Please note that web links and email addresses are some of the fastest things to change in our world. They are current as of the time of publication, but may change or disappear in the future.

73 de Paul R. Jorgenson KE7HR NSS 39382 FE ke7hr@mindspring.com

Theory and Designs for Building a White LED Headlamp

Doug Strait, dlstrait@bellsouth.net

This article has been written to assist those who wish to construct a headlamp using white LEDs. (Some of the LED specifications may be slightly out of date, but the concepts and designs are still valid.)

BACKGROUND

White LEDs are actually solid state fluorescent lamps consisting of a LED emitting blue light which excites a phosphor which emits white light. These LEDs were developed by the Japanese company Nichia and subsequently have also been manufactured or marketed by HP, Chicago Miniature Lamp, and Sloan Precision Optoelectronics in addition to Nichia. When introduced several years ago, Nichia reported typical efficiencies to be 5 lm/watt. By Sept 1998 the average of current production had reached 10 lm/watt. As of mid-1999 they are yielding 15 lm/w. This efficiency is similar to commonly used (for caving headlamp applications) incandescent bulbs. It should be noted that efficiency (for Nichia LEDs) is not a specified parameter and thus is not guaranteed.

If efficiency of the current white LEDs does not exceed typical incandescent lamps, why bother? In a properly designed headlamp, LEDs are immune from burnout. LEDs make much more efficient use of available battery energy from nearly depleted batteries. When the current to white LEDs is reduced by their light output will remain at over 50% of its initial value. In contrast, an incandescent lamp would have its light output reduced to less than 2% of its initial value. These LEDs are therefore more practical for selectable power level arrangements than are incandescent lamps. The I vs. V characteristic of these LEDs is very well matched to that of a nearly depleted battery comprised of 4 alkaline cells. Several days of low level illumination are attainable from batteries that will not light an incandescent lamp at all.

As one who has been involved in several entrapment by flooding adventures, I find this inherent long reserve to be very attractive. While it is widely understood that for color vision the human eye is most sensitive in the green portion of the spectrum, it is less widely know that for scotopic (low level B&W) vision the eye's sensitivity peaks in the blue portion of the spectrum. The spectra of these LEDs are rich in the blue portion where fully dark-adapted eyes are most sensitive.

White LEDs are limited in their power handling capability. The common T1 3/4 size has an absolute maximum rating of 120mw. It should be noted that unlike incandescent lamps, the efficiency of white LEDs increases with decreasing power level. The 10 lm/watt figure given above is at a current of 20mA which corresponds to a power level of about 68mw. Due to the limited power capability of a single LED, a minimum of 7 is required to achieve a reasonable level of illumination. Seven LEDs driven by a total current of 200mA provide illumination approximately equal to a carbide caplamp running a 1" to 1 1/2" flame.

Unlike incandescent lamps, LEDs (with rare exceptions) require some means of regulating the current they draw when powered by a battery. In its simplest form this can be a resistor inserted in the circuit between the battery and the LED. The disadvantage of this arrangement is that the current to the LED will vary as the battery voltage varies. For application as a primary headlamp, a far better circuit is one that will supply a constant current to the LED even as the battery voltage varies. In its simplest form, this can be achieved using a circuit comprised of only 2 resistors and 2 transistors. This circuit can maintain a constant current to the LED as long as the battery voltage is at least 0.6V greater than that of the LED at the desired current.

In the common T1 3/4 size, Nichia offers white LEDs with viewing angles of 20, 50, and 70 degrees. The viewing angle is that angle within which the intensity is at least 1/2 of the peak intensity. These LEDs do not differ in total light output but only in how widely or narrowly that light is projected. Those LEDs with viewing angles of 20 and 50 degrees are of most interest for headlamp application. Unfortunately, to present (11/98) only the 50 degree LEDs are offered at reasonable prices by distributors. While it is possible to obtain any of these LEDs directly from Nichia, the small quantity price of $12/each is prohibitive. The catalog distributor, ALLIED Electronics, lists a 20 degree LED by SLOAN Precision Optoelectronics at a good price but as of 11/98 they do not as yet have any inventory. To date the best price found for the 50 degree T1 3/4 size in small quantities is $3.99 each from HOSFELT Electronics.

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GENERAL DESIGN AND CONSTRUCTION GUIDELINES

White LEDs are reported to be electrostatic discharge (ESD) sensitive. During handling and construction good ESD hygiene should be observed.

As previously stated, efficiency increases with decreasing current. Testing of several samples has shown that efficiency reaches a maximum at a current around 3mA and is fairly constant in the 3 to 1 mA range. Considerable variation among samples was found for currents less than 1mA. Efficiency at 3mA is approximately double that of 30mA. While the absolute maximum rated current for these LEDs is 30mA, significant efficiency gains can be had by operating below this maximum. While current prices preclude taking this to the extreme of operating huge numbers of LEDs at 3mA each, the reduction from 30mA to 20mA will net an efficiency gain of 18% and a reduction from 30mA to 15mA a gain of 31% (on a current, not power basis). As prices decline it will become increasingly attractive to use larger numbers of LEDs, each operating at lower current.

VERY IMPORTANT: The following point cannot be over emphasized. Good thermal management is essential to long-term reliability of headlamps based upon white LEDs. While operating at power levels sufficient for a primary headlamp, a watt or more of power is likely to be dissipated among the LEDs and the current regulating circuitry. This heat must go somewhere. The light output of these LEDs will deteriorate over time if operated at excessive temperatures.

For groups of 7 or more LEDs with a combined current of 200mA, it is recommended that they be mounted on a doublesided PCB, preferably with 2 oz (.0028") copper cladding. The cathode (negative) leads of the LEDs should be soldered to both sides of the PCB and the maximum area practical of both sides of the PCB be devoted to the cathode connection. Due to the construction of the LED, almost all heat conduction from the LED die is via the cathode lead. The absolute maximum operating temperature of the LED die is 100° C. The lower the operating temperature the better for long-term maintenance of efficiency. The thermal resistance from the LED junction to the stopper on the cathode lead (about 0.1" from the LED body) is around 220 C° /watt. From the cathode lead heat must be conducted away and dissipated by the copper cladding of the PCB to which the LEDs are soldered. More is better in terms of both copper area and thickness.

The Table 1 shows the average Voltage vs. Current characteristic of a sample of 10 LEDs that were all presumed to be from the same production lot. All references to tested samples are for Nichia PN NSPW510BS which is a 50 degree, T1 device.

Table 2 shows how efficiency varies with current for a small sample that I tested [Lot 9906S2-bS, late 1999]. Efficiencies are normalized to that at I=20mA and are given both on current , Eff(I), and power, Eff(P), bases. Caveat: these measurements were made with a photodetector not corrected to the CIE photometric luminosity function and therefore their accuracy are dependent upon my assumption that the spectra of these LEDs does not vary with with current.

Note that the V vs. I figures of Table 1 are average values and there will be some variation among individual LEDs. This variation will cause unequal sharing of current among a group of LEDs that are operated in parallel. Based upon testing of a limited number of samples it appears that if you are using LEDs in parallel from the same production lot and operating at an average current of 20mA per LED or less, it is probably unlikely that any individual LED will exceed 30mA. If operating at average currents above 20mA per LED it would be prudent to individually test each LED and avoid using those which have voltage drops significantly below the group average at a constant test current. Suggest screening criteria: for an intended group average of 25mA, discard samples with a voltage less than the group average by 0.10V or more at a test current of 30mA; for an intended group average of 30mA, discard samples with a voltage less than the group average by 0.05V or more at a test current of 30mA.

A simple and effective circuit for maintaining a constant current to LEDs is shown in Figure 1. This circuit is well suited to powering white LEDs from a battery comprised of 4 alkaline cells.

Table 1: Average Voltage vs.Current

Volts	mA
2.83	2.5
2.96	5
3.14	10
3.28	15
3.41	20
3.52	25
3.63	30
3.75	35
3.86	40
3.95	45
4.08	50

Table 2: Relative efficiency

I(mA)	Eff(I)	Eff(P)
3	1.22	1.41
5	1.18	1.31
10	1.10	1.17
15	1.03	1.06
20	1.00	1.00
25	0.96	0.93
30	0.92	0.88
35	0.88	0.83

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R1 ≈ 500/I
R2 ≈ 0.54/I

Where I is the desired total LED current
R2 determines desired current

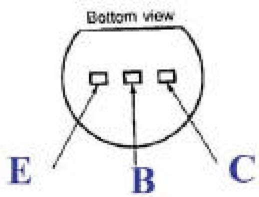
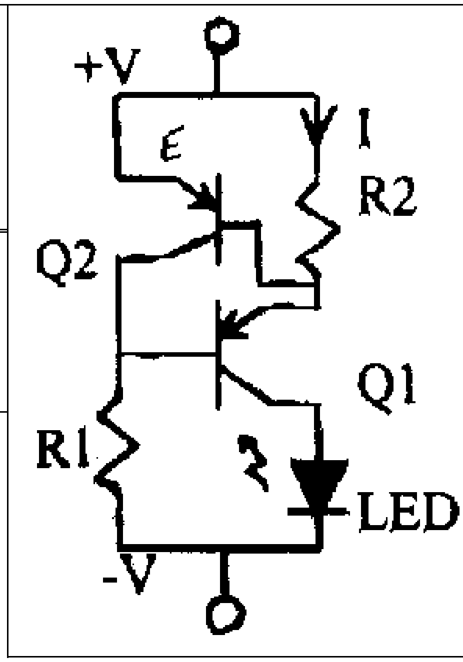


Figure 1: Simple Regulator and pinouts for TO-92 packages



It should be understood that the LED depicted can be any number of LEDs in parallel. Q1 is the power dissipating element in this circuit and appropriate mounting consideration must be given to heat dissipation. Generally for TO-92 packages and small surface mount packages the collector lead is the one by which most of the heat is transported from the package. The PCB layout should maximize the copper connected to the Q1 collector lead. Q2 may be any SS PNP with good gain (H_{FE}). For Q1, a recommended device in a TO-92 package for through-hole construction technique is the ZETEX ZTX788A.

For surface mount construction technique a recommended Q1 is the ZETEX FMMT717 or FMMT718 which come in the SOT-23 package. Suitable Q2 in through-hole TO-92 package include 2N3906, 2N4403, and 2N5087. Suitable Q2 in surface mount package (SOT-23) include MMBT3906, BCW61D, and MMBT2907A. Resistors R1 and R2 may be 1/8 watt size unless the desired current is greater than .25 amp in which case the wattage of R2 should be increased. By use of surface mount devices for Q1 and Q2 it is possible to construct the current regulating circuit on a 0.32" x 0.32" x 1/32" doublesided PCB that will fit inside the base of a "PR" style (flanged base) bulb. By soldering the PCB that holds the LEDs directly to the flange of the bulb base one can thereby create an LED version of a "PR" style bulb.

In the case of some headlamps, the only required modification to the headlamp itself to accommodate the use of the LEDs will be enlargement of the hole in the reflector to accommodate the diameter of the LED cluster. By devoting the majority of the LED PCB to the cathode (negative) side of the circuit and soldering this PCB directly to the bulb base flange, the bulb base becomes part of the heatsink for the LEDs. Due to the limited area of PCB that can be fitted into a "PR" style base, about the absolute maximum current that can be handled by a current regulator circuit fitted into a "PR" base is .25 amp assuming use of 4 alkaline cells as the power source. Even so, this value assumes use of DS 2 oz clad board with the maximum area possible allotted to the collector lead of Q1. Pushing this limit risks reliability degradation due to the thermal stresses upon Q1. Those who wish to operate at higher currents or wish to simplify layout considerations on the PCB can enlarge the PCB that holds the LEDs and move the current regulator circuit to this PCB.

HELPFUL HINT: Even if you don't have the capability to fabricate PCBs by chemical etching techniques, simple PCB circuits such as these can be created using a Dremel-type tool to remove the unwanted copper from clad board stock. All that is required is a small burr and a steady hand.

USING OTHER POWER SOURCES: The current regulation circuit of Figure 1 will maintain regulation for battery voltages >0.6V above that required by the LEDs. This circuit is marginally acceptable for use with 4V Pb-acid batteries if the average LED current is 15mA or less. For other battery choices such as 3 Ni-Cd or Ni-MH cells, or a single Li-ion cell, there is less than this required 0.6V of "headroom" for a significant portion of the discharge. For these applications an alternate circuit is offered in Figure 2 below. This circuit will maintain regulation for battery voltages as low as 0.1V above that required by the LED.

R1 = 0.064/I
R2 ≈ 300/I
Where I is total LED current
C1>1µ F

The LM334 is a 3-terminal adjustable current source. It operates to maintain 64mV between its R and V- terminals (hence across R1) and does so by passing current into the V+ terminal and out of the R terminal. Assuming adequate cell voltage, the LED current is the beta of Q1 times the R2 current. R1 sets the LED current which is 64mV/R1 for reasonably high Q1 beta. Hence R1=64mV/I where I is the desired LED current. R2 is selected

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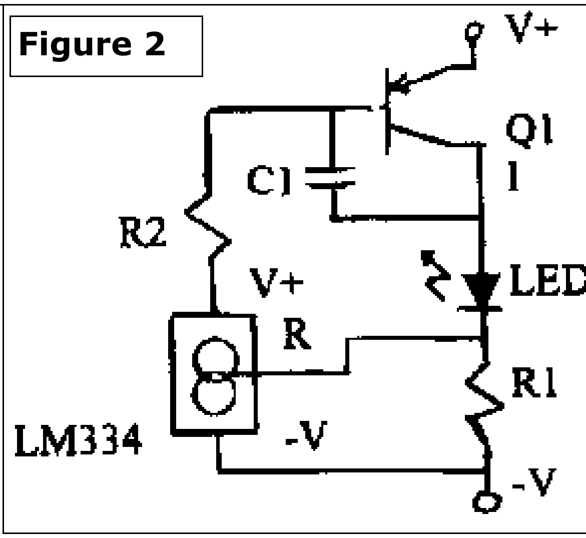
to regulate the base current to an appropriate value when the battery voltage drops to the point that the circuit falls out of regulation. Under this condition the LM334 will draw all the current it can through R2. C1 prevents the circuit from oscillating and any value from 1 to 10µ F works well. Suggested Q1 choices are the same as given for the previous circuit. The LM334 IC is available in both TO-92 and SO-8 packages.

Another current regulation option exists. This is the use of a step-down switching regulator arrangement. For most applications the gains are probably insufficient to justify the added expense and complexity of the associated circuitry. As the difference between the average available voltage and the voltage of the LEDs at the desired operating current increases, the use of a step-down switching regulator circuit becomes increasingly attractive. I will not elaborate further on this option other than to say that of the ICs that I have examined for this application the MAXIM MAX887 appears most attractive.

Figure 2



CONSTRUCTION PROJECT USING A SPECIFIC HEADLAMP

There is an inexpensive headlamp on the market that is (with care) waterproof and utilizes 4 AA cells. This headlamp has been variously labeled "Optronics Nightblaster," "Safesport Waterproof Headlamp," and "Eveready Waterproof Headlamp" and can be found for $10 or less.

Considering the price it is well made. I have successfully used this headlamp as a starting point for various lamp modification projects. I have used this lamp with "PR" lamp base LED assemblies. With careful attention to layout, it appears that this headlamp could accommodate up to 30 T1 3/4 size LEDs. To date the largest number I have used is a cluster of 7 operating at a total current of 200mA. Since these LEDs are operating near their maximum rated current, careful matching of LED characteristics is required. Component values for this lamp using the circuit of Figure 1: R1=2.2KΩ , R2=2.7Ω , Q1=ZETEX FMMT718, Q2=MMBT2907A.

If component cost is not a primary consideration, maintaining the same component values (and thus current) but increasing the number of LEDs to 10 or 13 will yield gains in light output of 15 and 28% respectively. Additional benefit of using the larger number of LEDs is the negation of the requirement to match characteristics and slightly longer runtime before the light intensity begins to decrease at the end of battery life. While my initial prototype utilized a 0.6" x0.6" PCB to mount the LEDs, I recommend that a larger PCB be employed to improve heat dissipation. Due to geometric considerations it is recommended that 1/32" thickness be used.

Performance of this lamp using fresh Eveready cells is as follows:

Constant brightness	9 hours
Additional hours to 50% brightness	6 hours
Additional hours to 25% brightness	2 hours
Additional hours to 10 % brightness	24 hours
Total hours to 10% brightness	41 hours

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Written November 1998, with revisions
April 2000 and 5 September 2000

Caving Technology Website Version 1, 21 April 2000
Caving Technology Website Version 2, 5 September 2000

SPELEONICS Version, July 2001

SOURCES OF COMPONENTS AND INFORMATION

Hosfelt Electronics 1-800-524-6464 White LEDs

Allied Electronics 1-800-433-5700,
http://www.allied.avnet.com/ White LEDs

DIGI-KEY Electronics 1-800-344-4539,
http://www.digikey.com/
ZETEX transistors, catalog component distributor

Nichia Website www1a.meshnet.or.jp/nichia/
Information on Nichia White LEDs

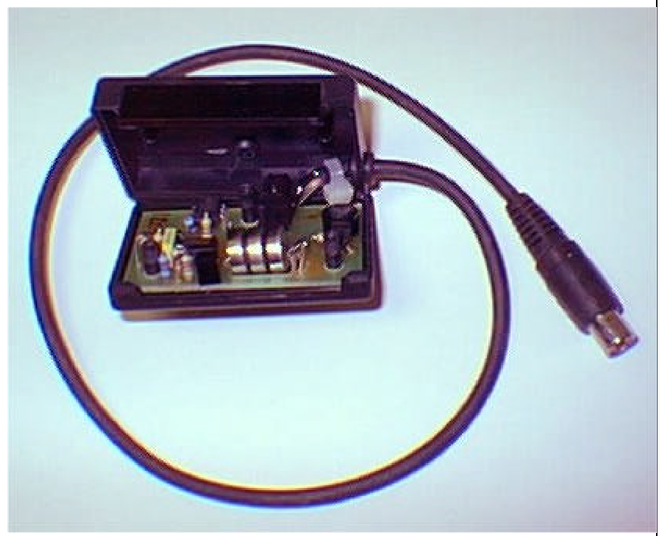
Firefly 2 Flash Slave Modification

Wm Shrewsbury, 22677RL,FE

[Original appeared in Cavers Digest - *SPELEONICS* version July 2001]

First off, let me say that the Firefly 2 is indeed a fantastic bit of circuitry! I have 4 of them and they take quite a bit of punishment and work beautifully.

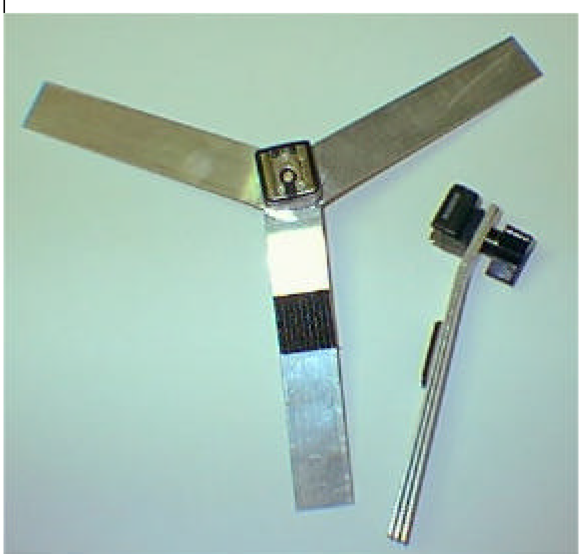
Peter Jones (the US distributor for the Firefly) includes direct wire modification instructions with them, but I opted on another method.



1) Open the slave and de-solder the supplied hotshoe foot.
2) Buy a simple female/female RCA cable from your favorite video cable supply place (Radio Shack is a good one in the US) and cut it in half. I recommend a black cable.
3) Solder the wires from 1/2 the female RCA cable into the slave.
4) Wire/Solder the other half into your flash.

Now each piece has a nice, sturdy, easily cleaned RCA jack. But wait - they're the same end! Now go buy a second cable, a male/male cable of any length you want (again, black) and connect the two. Now you can set the flash up where ever you want, in any angle you want, and put the slave where ever you need it for firing purposes.

I carry a couple of short cords, the 12' ones, for close 'normal' stuff, but also some 20' ones for those 'really out of the way' shots. With a couple of female/female adapters you can even join long cords!



Now, the hotshoe you took off...

1) Buy a 1" wide x 1/8" thick strip of aluminum bar and cut three 6" pieces off. Be sure to sand the cut edges.
2) Line up the 3 pieces together (important - together!) in a vice and drill a 1/4 hole about 1" from one end right in the center (center as in the middle of the short dimension.)
3) Now put the end with the hole(s) about 1" into the vice, still together, and bend them about 45 degrees.
4) Go to your local hardware store and buy a small knob used to replace those on pots, drawers, etc. that has a built in 1/4 threaded bolt. Ace Hardware in the US has quite an assortment of them.
5) While you're at it, get a rubber washer with a 1/4 hole.
6) Put the knob bolt through the hole you drilled in the strips, place the rubber washer on top of the shaft, then screw it into the hotshoe foot you removed from the Firefly earlier.

Instant mini tripod for your flash! Just loosen the knob, rotate the legs and tighten. Nothing wasted! I also took the Velcro that comes with the Firefly and put it on the top leg for close attachment. To store just loosen the knob, rotate the legs together and tighten. Easily fits in the small pelican cases!

Since the legs are aluminum, you can bend them if really needed to fit really weird setups. If you use a flash with a tilting head like the tilt-a-mite, then you can have up and down control. Just loosen the hotshoe to ro-

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tate.

List of parts for the slave:
1 - Firefly 2
1 - female/female RCA cord, short
1 - male/male RCA cord, length your preference

List of parts for the tripod:
1 - knob with 1/4 shaft
1 - 1" wide x 1/8" thick aluminum bar cut into three 6" pieces
(comes in various lengths from 1' to 8')
1 - rubber washer

This allows me to spread my 'tripods', put my tilt-a-mite flash in the hotshoe, set up the flash and Firefly where I want them, connect the M/M cord, load a bulb and then move on to the next. Multiple flash firing never been easier!

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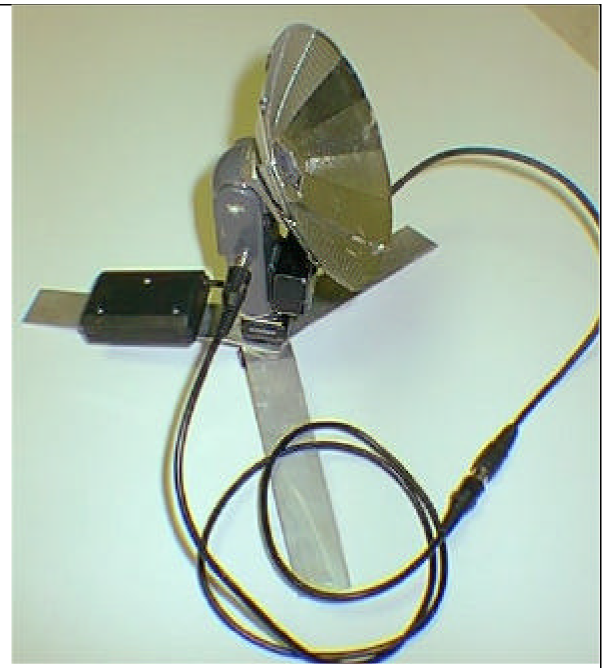

LIGHT BULBS FOR CAVING HEADLAMPS IN THE 21ST CENTURY

by John T. M. Lyles

There are a number of companies that sell or make halogen, krypton and standard tungsten bulbs for flashlights (called miniature bulbs in the trade). In this report, I will concentrate on miniature flanged and screw based bulbs suited for 3 or 4 C and D cells, as well as F cells. This includes suitability with Alkaline and rechargeable cells. Lamp housings for these bulbs include the Justrite Electric, Petzl headlamps, Easter Seal/Roosa Light, FX light, Nitelight, Bob and Bob, REI, Ray-oVac Sportsman, Radio Shack, and many other standard sockets.

NA Philips Lighting
GE (impossible to find info on anymore)
Osram (Sylvania connection, German company)
Orbitec (French company)
Thorn-EMI (UK company)
And Far East sources that are not known at this time

Screw-in bulbs are what I like to use in my Easter Seal/Roosa Lamps. Some people force a miniature flanged tungsten halogen (TH) bulb of the HPR-50 to 55 variety into the socket, by bending the metal that contacts the outer metal of the base. This can work loose, and later ruin the socket for screw-in bulbs. My most recent Easter Seal/Roosa was shipped with a #27 standard bulb. Some cavers use the #425, or 605 as an upgrade. I use the TH HPR55 equivalent in a screw-in base from Orbitec, H06330. This is an excellent bulb, if used with a dimmer or other methods to take the edge off of new D cells before it is used. Otherwise you run the risk of burnout for the first 4 hours of Alkaline cell discharge. One way that I used for years is to swap to a 6 Volt bulb such as the Petzl F0500 or the #605 incandescent bulb for the first 4 hours. This requires remembering, and also carrying the bulbs in a safe place. Memory is easy, as those bulbs become quite inefficient and provide low light output after the cells have dropped to 1.3 Volts each. For the full life expectancy and brightness of TH bulbs, you should run them in the halogen cycle, which means getting the envelope hot enough to cause the regeneration of tungsten back to the filament. This is about 200-250 deg C on the envelope! Most of us don't get to that point as the lifetime of the filament is shorter, but the light is very bright. Backing off a TH isn't as bad as it sounds. Just remember to run it bright occasionally. This is an area lacking research, how long must you cook your bulb to get the tungsten deposit off the glass and back on the filament. But when you need a bright light, a TH bulb at rated operation is an great lamp. I always wipe off the envelope before lighting it off, and also keep an eye for reflector melting in the Roosa. One of mine has a slight warp on it where I forgot and left the bulb at maximum with new batteries.

The Orbitec (French) catalog has a description of the various screw-in TH bulbs here. Mine is dated 1988. Lamp Technology is a bit more stingy with their source literature. Bulbtronics is another distributor (800) 654-8542. Bulb Direct also sells some of these at (800) 772-5267. All of these companies are in NY state. Other sources include Sunray Light-

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ing (800) 854-4487, The Light Bulb Shop (800) 282-2852, Mouser Electronics (800) 346-6873, Digi-Key (800) 344-4539, and Newark Electronics (see local numbers in phone your book).

Here is a listing of the bulbs for flashlights. Luminous intensity is measured in candlepower, Cd (Candela's). To be more precise MSCP is mean spherical candle power. It is a non-SI unit measuring the intensity of a light source if it were spread evenly in all directions. With bulbs this is an acceptable measurement for comparison. With LED's and focused lamps, this isn't very useful. Some literature refers to luminance and the unit Lumens. Lumen = MSCP x 4 x pi (3.14), and is a weighted measure of luminous flux in a specified direction.

1 Cd at 1 foot = 1 foot candle = 1 MSCP. I refer to Cd in my list for brevity, but actually it is MSCP.

Volts x Amps = power requirement in Watts

I borrowed the efficiency rating idea from the article by Anne Strait and in the LEARN newsletter article by Doug Strait [refs. below]. The higher the Cd/W, the more efficient the bulb is in converting the electrical energy into light as measured in a standard setup. None of this takes into account the relative efficiency and uniformity of reflectors in the various headlamps. Remember that a lot of the electrical energy is turned into heat in a filamentary lamp, so real efficiencies would be dismal to list and compare.

Flanged Base for standard flashlights (mostly 3 or 4 cell listed here):

				life	@ rated power
PR 3	3.57 V	.50 Amp	1.50 Cd	15 hr.	@ 0.84 Cd/Watt
PR 7	3.70 V	.30 Amp	0.90 Cd	30 hr.	@ 0.81 Cd/W
PR 12	5.95 V	.50 Amp	3.00 Cd	15 hr.	@ 1.01 Cd/W
PR 13	4.75 V	.50 Amp	2.00 Cd	15 hr.	@ 0.84 Cd/W
PR 15	4.82 V	.50 Amp	2.00 Cd	30 hr.	@ 0.83 Cd/W
PR 17	4.90 V	.30 Amp	1.20 Cd	30 hr.	@ 0.82 Cd/W
PR 29	3.60 V	.20 Amp	0.60 Cd	30 hr.	@ 0.83 Cd/W
PR 30	3.75 V	.86 Amp	2.25 Cd	40 hr.	@ 0.70 Cd/W
PR 32	4.80 V	.70 Amp	3.20 Cd	30 hr.	@ 1.05 Cd/W

Krypton Gas types

KPR 103	3.60 V	.70 Amp	2.70 Cd	15 hr. @ 1.07 Cd/W
KPR 113	3.80 V	.70 Amp	4.06 Cd	15 hr. @ 1.21 Cd/W
KPR 139	3.85 V	1.20 Amp	5.10 Cd	15 hr. @ 1.10 Cd/W
KPR 140	4.00 V	.90 Amp	4.00 Cd	15 hr. @ 1.11 Cd/W

TH types

HPR 36	5.50 V	1.00 Amp	7.95 Cd	40 hr. @ 1.45 Cd/W
HPR 40	6.00 V	.67 Amp	6.00 Cd	50 hr. @ 1.49 Cd/W
HPR 41	3.75 V	.75 Amp	3.10 Cd	100 hr. @ 1.10 Cd/W
HPR 50	5.20 V	.85 Amp	6.77 Cd	25 hr. @ 1.54 Cd/W
HPR 51	6.50 V	.70 Amp	7.16 Cd	25 hr. @ 1.57 Cd/W
HPR 52	2.80 V	.85 Amp	2.78 Cd	25 hr. @ 1.17 Cd/W
HPR 53	4.00 V	.85 Amp	4.77 Cd	25 hr. @ 1.41 Cd/W
HPR 54	4.00 V	.50 Amp	2.63 Cd	15 hr. @ 1.31 Cd/W
HPR 55	5.20 V	.50 Amp	3.82 Cd	15 hr. @ 1.47 Cd/W

Screw-in bulbs (also called E10 by Orbitec, and Miniature Screw Base by Chicago Miniature)

13	3.70 V	.30 Amp	.98 Cd	15 hr. @	0.88 Cd/W
27	4.90 V	.30 Amp	1.40 Cd	30 hr. @	0.95 Cd/W
31	6.15 V	.30 Amp	2.00 Cd	15 hr. @	1.09 Cd/W
425	5.00 V	.50 Amp	2.30 Cd	15 hr. @	0.92 Cd/W
502	5.10 V	.15 Amp	0.60 Cd	100 hr. @	0.78 Cd/W
605	6.15 V	.50 Amp	3.40 Cd	15 hr. @	1.11 Cd/W
FR 0021	4.5 V	?			

Petzl Incandescent bulb for Zoom, Mega, Laser, Artic, Crono

(Continued on page 10)

(Continued from page 9)

TH types

H05730	4.0 V	.50 Amp	see HPR 54	15 hr.
H05930	4.0 V	.85 Amp	see HPR 53	25 hr.
H06330	5.2 V	.50 Amp	see HPR 55	15 hr.
H06530	5.2 V	.85 Amp	see HPR 50	25 hr.
FR 0025	4.0 V	.50 Amp	2.63 Cd	15 hr. @ 1.31 Cp/W Petzl Halogen Bulb*
FR 0500	6.0 V	.40 Amp		(Thorn K16430) another Petzl Halogen Bulb

* I have two different Petzl packages for this same FR 0025 bulb, one is marked 4.5 V, 2.25 W. This bulb is suited for the Zoom, Mega, Laser, Crono, and Artic lights.

Conclusion

Pick your bulb from the chart above. As battery technology improves, you will get longer burn time. Without a dimmer, my 5.2 V .5 Amp system burns over 30 hours in expedition caving. With a dimmer, I am now getting at least 80 hours of operation from four D cells, as I can control the exact amount of light I need and save energy. There are several good dimmers on the market, and many homemade ones. With the advent of white LED lights, why bother? You thought the same thing when electric lights came and carbide was put in your closet. There are still a lot of advantages to Tom Edison's light bulb in cave illumination.

References on electric headlamp bulbs for caving:

Bulbs - That will light up your cave
Morley Hardaker, Valley Caver, from Mother Lode Grotto, late 1980's

Krypton Bulb Adaptation for the Justrite Electric Headlamp
NSS News, V44, n8, August, 1986

A Short Bibliography of Electric Cave Lighting 1958-1987 (NSS-USA)
Bill Torode, Speleonics 8, 1987

Halogen Lamps for Caving
Joe Jette, Arizona Caver, February 1987

Illuminating Facts for Electric Cavers
Dave Bunnell, The Explorer, March 1989

Lightbulbs of Interest for Caving Application
Anne Strait, Pecos Valley Grotto New, October 1992

A Good Electric Light For Long Trips
Donald Davis, Rocky Mountain Caving, Winter 1993

Incandescent Lamp Parameter Variation with Voltage
Doug Strait, Speleonics 18, 1993

Incandescent Electric Headlight Systems for Long Duration Expeditionary Caving
Doug Strait, LEARN Network News, V3, n1, January, 994

Why Three Sources of Light? a lesson in reliability to make you a safer caver
Mike Substelny, Cleve-O-Grotto News, V42, n9, September 1996

Foot-Candles: Photometric Units
David Gibson, BCRA CREG Journal 29, September 1997

Light in Lechuguilla or How to Spend Seven Days in Lech with Only Four D cells
Art Fortini, LEARN Network News, V7, n3, Winter 1998

CONSTRUCTING A LINEAR CONSTANT CURRENT DIMMER FOR A WHITE 24-LED ARRAY

Brian Pease

This simple Linear circuit provides continuously variable regulated current (~25-400mA) from a 4-6 Volt source. I chose a linear design for simplicity, reliability, ease of repair, and to avoid switching EMI in my Cave Radios. The circuit requires only 0.2V headroom above the parallel LED Array voltage to provide regulated maximum current. The headroom stays low until the LED's are extinguished at about 0.75V/cell for 4-cell packs. End of life for alkalines is usually considered to be 0.9V/cell. My HDS 24-LED array requires 2.9V at 25mA and 3.5V at 440mA. The circuit can be scaled for larger or smaller arrays, and should actually handle several Amps with a larger heatsink. With 4 AA Alkalines, life should be 3 hours (or more) at maximum setting for a 24-LED array, but ~60-80 hours at minimum setting, which is bright enough for many activities, including reading, if the mounting bracket allows the lamp to pivot downward like mine does. In a two week test, I found that the white even light made caving easy. The "rings" and sharp cutoff of halogen lamps are absent. I found that I could usually get away with 200mA when moving, and much less when stationary (surveying, resting, eating), getting up to a10 hour trip from 4 AA's. The real beauty of white LED's is that the light remains white even at the lowest settings, compared to halogen light which shifts rapidly to infrared when dimmed.

The battery pack can be 4 AA, C, or D size Alkaline, Ni-Cad, NiMH, 1.5V AA Lithium cells, or a 6V Lead-Acid. 3-cell C or D Alkaline packs should also work, but they will not be discharged as deeply. "Dead" cells from Halogen lamps, GPS, etc., should give hours of "free" light at lower current settings. My latest pack is two 3V, 8AH lithium cells removed from a military surplus BA-5598/U battery (5 cells/battery). These are available from Fair Radio Sales at http://www.fairradio.com at 2 for $6.50 plus shipping.

My headpiece is an old waterproof "Easter Seals" Lexan "Roosa" light with a rocker on-off switch. See http://users.erols.com/agmw, but I am told to call them directly (860-728-1061 in CT) and talk to Skip. All the parts are available separately, including the headpiece, battery packs, and replacement lenses. They also sell a complete headlamp with halogen bulb (and spare) with Willy Hunt's microcontroller switching voltage regulator (not suitable for LED's) for $55 retail, but maybe at $45 if you are worthy.

Because I am lazy, I purchased a 24-LED array from Henry Schneiker of HDS systems at http://www.hdssystems.com or 1-877-437-7978 (toll free). The Nichia LED's have a 20 degree half-beamwidth with significant sidelight, which seems ideal. I am told that a good source for these LED's is http://www.whiteleds.net.

They are listed at $1.75 each, but I am told that they can be had for $1.50 each for 50+, with free shipping.

See Garry Petrie's "Perfect LED Light" at http://home.europa.com/~gp/perfect_led_light.htm for detailed technical info on white LED's and a simple way to assemble an LED array on a do-it-yourself circuit board. He shows how to install arrays into Petzl Micro and Mega headlamps using switching regulators. However, the regulators themselves are constant voltage rather than the desired constant current, and are the lamps truly submersible?

An excellent Website. Another resource is the LED Flashlight Page, http://www.uwgb.edu/nevermab/led.htm.

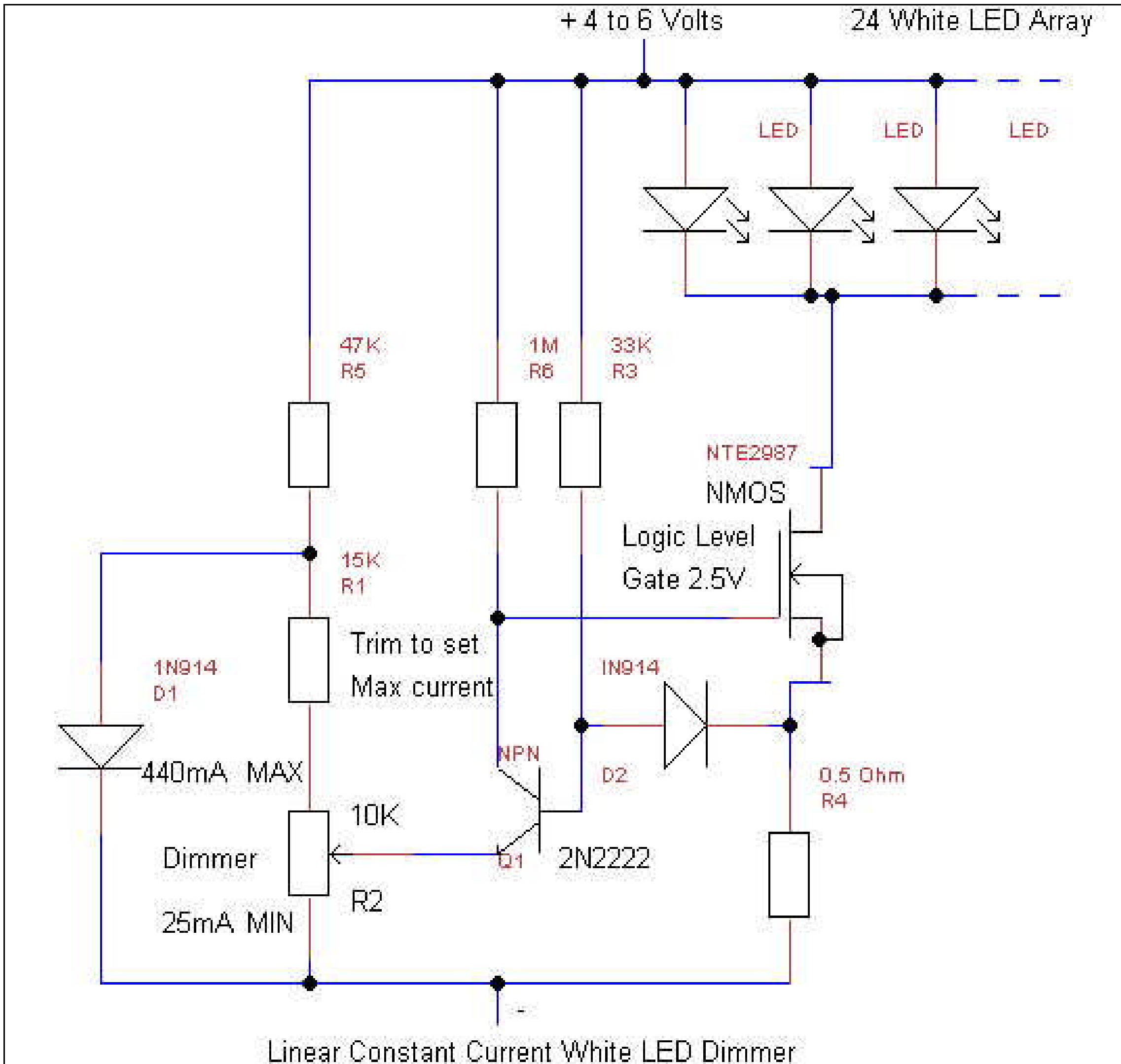
DETAILED CIRCUIT DESCRIPTION

I used a commercial array because of the careful voltage matching required in order to obtain anywhere near equal light from each LED when they are wired in parallel (and avoid overheating at full power). I would have to had purchase a large quantity of LED's to solve this problem. This was expensive, but was the only real cost.

The MOSFET current source can be any N-channel enhancement mode unit designed to be driven by "logic level" signals. It must fully turn on at 400mA with Vgs<3V. Beware of static electricity on the gate of this unit! I destroyed the IRLZ34N used in the breadboard when I soldered it into the actual unit. A small 1" square of sheet aluminum serves as a heat sink. Dissipation is about 0.9 watts at maximum current with a true 6V worst case source.

R4 samples the LED current. Voltage drop is 0.2V at 400mA. If a much larger or smaller array is used, R4 should be adjusted to give ~0.2V drop at maximum array current (~20mA/LED).

(Continued on page 12)



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Q1, D2, R3, and R6 form a simple "single supply" op-amp that can sense the voltage across R4 nearly down to zero volts. The forward voltage drop across D2 is nearly identical to the base-emitter drop of Q1, thus the voltage between the arm of R2 and ground is the same as the voltage across R2. D2 provides nearly perfect temperature compensation for the dimmer control, which becomes very critical at the dimmest settings.

R5, and D1 provide a regulated voltage for the dimmer control R2. This voltage, about 0.5V, is not temperature compensated, but is not critical in this design.

If R2 is set to max current, 0.2V will appear on the base of Q1. The collector current of Q1 will be momentarily be cut off, which will turn on the MOSFET. The voltage across R4 will rise until it reaches 0.2V, giving an array current of 400mA. Q1 will then turn on, regulating the array current.

R1 is the only critical part. R4 must be chosen to provide the desired maximum array current at the maximum setting of R4.

The drop across the LED array is ~3.5V at maximum current. As the batteries die, the drain-source voltage of the MOSFET gradually drops to zero, and regulation is lost. The lamp will gradually dim, but the MOSFET will stay locked ON, with the only wasted power being the drop across R4. Dimming the lamp will bring it back into regulated mode for a while. This circuit extracts nearly all of the energy in the battery pack, down to 0.75V/cell for a 4-cell pack.

The ~25mA minimum array current results from slight differences in the forward voltage drops of D2 and Q1. If desired, replacing D2 with the base-emitter junction of a second 2N2222 should reduce the minimum current to ~zero.

There are variations of this circuit such as one by my

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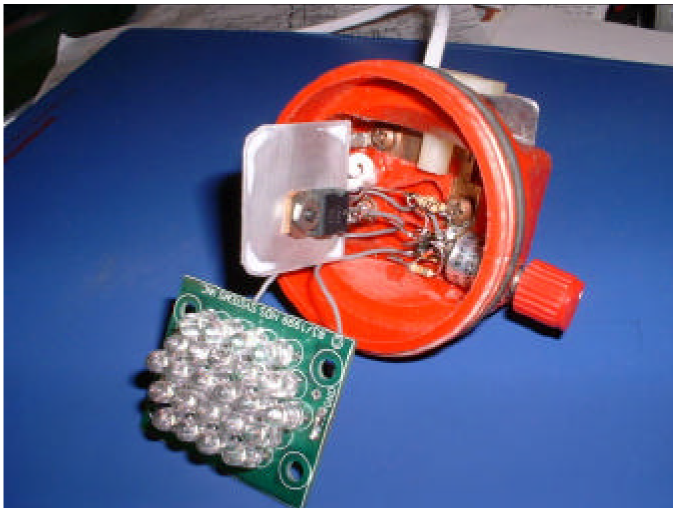
Unmodified Headpiece Interior View



Headpiece with wiring in place

(Continued from page 12)

namesake Bob Pease in the Sept 5, 2000 issue of Electronic Design Magazine using a voltage regulator and a BJT. Another variation uses a real low voltage single-supply op-amp in place of Q1 and either a BJT or MOSFET.

CONSTRUCTION

First,I breadboarded the entire circuit in order to test the design and set the maximum current limit.

Next, I "hogged out" the interior recess of the Lexan Easter Seals headpiece with a Dremel Tool, and also removed unneeded metal from the switch contacts. The 1/2" diameter pot was positioned as far to the rear as possible so that the knob (1/8" shaft) would clear the lens when the lens was screwed on. Point-to-point wiring was used for the regulator, without a circuit board. Everything was installed as far to the rear as possible to allow the TO-220 MOSFET to fit over the circuit with a flat aluminum heat sink cut to fit into the recess. Stranded hookup wire was used to make the 3 connections to the MOSFET. Spacers of Index card paper were used above and below the MOSFET to prevent shorts. The LED array sat on top of the recess, resting on its 4 corners. A large hole was cut in the plastic reflector, by slicing off the back, to clear the LED's on the arrays' circuit board. The main purpose of the reflector is to hold the LED array firmly in place when the clear lens is screwed on, but it actually does direct a little light forward and besides, it looks cool.

Battery Pack with LED s in place

Black electrical tape was wrapped around the flange of the lens to keep direct light out of the users eyes. Calibration marks were melted into the housing to calibrate the dimmer knob every 100mA (1,2,3,4).

Water must be kept off the circuit. Specifically, water on the high-impedance MOSFET gate line will cause the array to go dim until the circuit is dried out. I used silicone rubber over all the wiring. I installed a $1.00 watertight swimmer's "dry" container on my helmet to hold the Radio Shack 270-409 battery pack. There is also room for 4 spare AA cells, although I simply bought 2 spare packs at $1.50 each and installed $.99 Molex connector pairs (274-222) which also allow use of the original Easter Seals Lexan belt-clip battery case, which holds 4 Ni-cad 4-AH D cells soldered together for a really long trip.

For long-life expedition use, I recently constructed a waterproof cylindrical pack to hold 2 of the surplus 8AH lithium cells mentioned earlier. The pack is simply a short piece of "1.5 inch" PVC pipe with a glued-on end cap on the top, and a clamp-on rubber cap on the bottom.The two separate wires exit the rubber cap through very small drilled holes which eliminates the need for any special sealing arrangement.

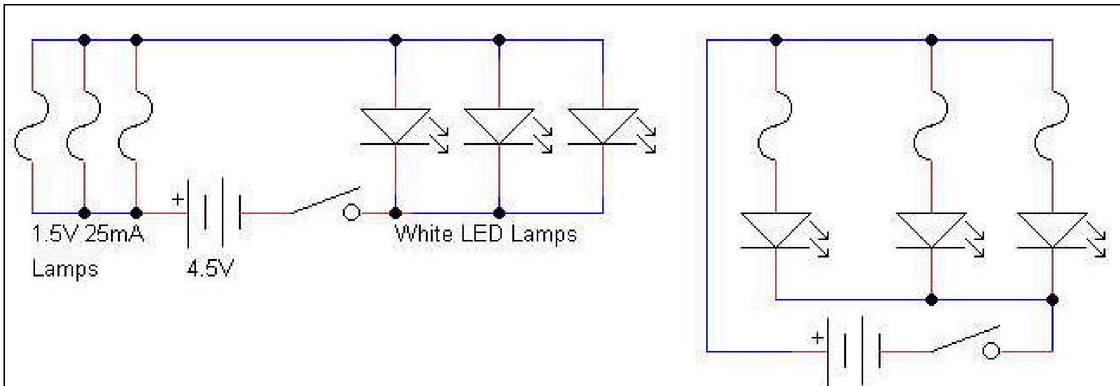
SIMPLE CURRENT LIMITING FOR LED FLASHLIGHTS

For Longer Battery and LED Life

Brian Pease

I have modified my 3-White LED 3-AA cell flashlight by adding filament bulbs in series with the LED's to form a "ballast" utilizing the positive resistance-vs.-temp characteristic of tungsten as a simple current source. I did this to increase the battery life (at the expense of initial brightness), and to increase the lifetime of the LED's. The flashlight, which was given to me, appears to be an early C. Crane unit. As in most of these simple lights, the 3 LED's are wired in parallel on a tiny circular PC board and connected directly to the 3 AA Alkaline cells. The light originally drew ~120mA with fresh batteries, which is 40mA/LED.

I lifted the positive LED leads and tied them together. The negative leads remained on the board for heat sinking. I wired three 1.5V 25mA mini-lamps with pigtail leads (US Radio Shack 272-1139) in parallel and connected them between the positive LED leads and the center contact on the board. There may be a 1.5V 75mA lamp available, but the 25mA units were "off the shelf". The schematic shows this arrangement as well as the possibly better arrangement of one lamp- one LED.



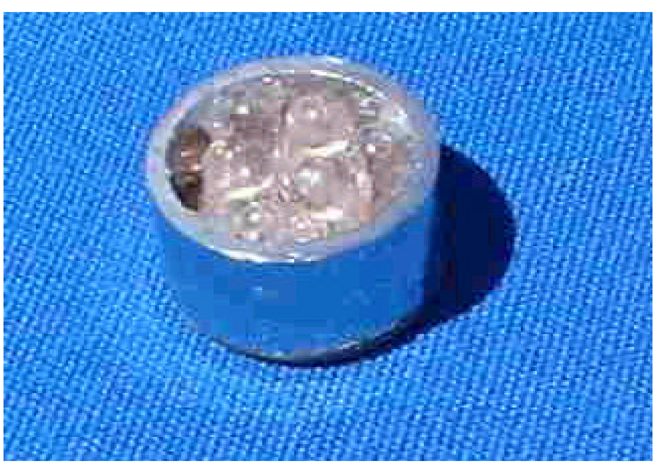
Flashlight Current Regulator Circuit

Alternate Circuit

In this flashlight, the 3 filament bulbs can be fitted around the LED's to make what appears to be a 6 LED module (which is also hard to photograph!)

The bulbs are far better at current regulation than fixed resistors. The table below gives current drain vs. applied voltage for this module. The maximum initial battery voltage for new cells with no load is 4.65V. 5.2V is the supply voltage that puts the maximum 1.5V on the bulbs. At the lower voltages, the bulbs are essentially a short circuit with little loss just like the original unregulated flashlight.

The plastic lens of the assembled flashlight is wrapped with electrical tape to prevent any trace of side-light. There is enough light for camp use, reading, or emergency travel. This light should run continuously for more than 2 days on a set of 3 AA alkalines, and the LED's should outlast the flashlight.



Ballast Performance

Supply Voltage	Ballast Voltage	Total Current
5.20 V	1.5 V	71 mA
4.70 V	1.1 V	60 mA
4.00 V	0.45 V	44 mA
3.75 V	0.26 V	39 mA
3.56 V	0.13 V	30 mA
3.48 V	0.096 V	25 mA
3.41 V	0.077 V	20 mA

Equipment Review: Leica Disto classic3 Laser Distance Meter

John T. M. Lyles   December 18, 2000

In 1998 I evaluated a Disto Basic laser meter at Carlsbad Cavern National Park. My report to the Park stated that the unit was bulky, fragile, and had a problem with the displayed distance. It was smaller than the original Disto, but at 8.8 x 3.1 x 2 inches in size, and weighing about a pound and a half, it was not going to be in every cave surveyor¹s pack. The price was $1300 US dollars at the time. But the Disto Basic was capable of measuring distances to 325 feet with +/- 0.2 inch precision. This allowed cavers to measure passage dimensions without dragging chain (tape) across delicate formations. It allowed us to quickly measure the dimensions of a room for more accurate sketching, beyond just left, right, up and down at the point. The Park bought two of the units, having large caves like Carlsbad Cavern and Lechuguilla Cave to measure and manage.

Now, Leica has done it better, smaller and cheaper. The new Disto classic3 arrived in a package of 6.7 x 2.6 x 1.7 inches weighing about 0.8 pounds. It is still capable of the same range and accuracy, but now uses smaller AAA cells now for up to 2000 measurements. The cost is about $500 ($595 suggested list). Leica has clearly improved the Disto, and listened to users. It has also eclipsed the competition in price.

The new Disto has a phosphorescent readout, which can be recharged by a caplamp and continues to be readable for about 10 minutes in a cave. The readout can be set for SI or English units, and will remember that state until reset again. And the worst fault of the Disto Basic, displaying feet, inches, and fractional inches, is fixed with a clear readout of feet with hundredths.

The Disto classic3 uses a pulsed 635 nm laser diode, with an average power of 0.95 mW (Class 2). The pulses are of 15 nS duration, and the peak power is about 8 mW. At regular intervals the unit measures an internal reference path. Beam divergence is 0.16 x 0.6 mrad, and the projected spot is stated to be 0.24 inches in diameter at 32 feet and 2.4 inches at maximum range. If rough walls are measured, such as a popcorn coating, movement of the spot will find the optimal reflection to lock in a reading within a second or so. The unit will then beep to acknowledge the stable result. It could just as easily be sighting a small hole or projection from a wall, giving the expected error of such a measurement of passage length. Having a point person to set stations is still required, and some caution needs to be exercised to prevent them from getting it in the eyes, having dark-adapted vision. Wet surfaces and pools can be a problem, reflecting too strongly a signal. The Disto classic3 will beep with an error code displayed. The reflected light should be diffuse without a high reflection. The best performance will be obtained at the longer ranges in a dark area, such as in a large cave passage! For medium length shots, a brown target is recommended; cave passages with rough walls should be more than adequate here too.

There are some built-in firmware features of the Disto classic3 such as finding the longest dimension in a continuous process of taking readings, for measuring the diagonal length into a corner (or getting the longest length of a passage). Another mode allows the shortest reading to be held, during a continuous process. This helps determine the distance to a flat perpendicular surface. There is also a mode to compute the height of an object using the Pythagorean principle from two or three shots. This is useful in cases where one cannot stand underneath the object and shoot vertically, such as when measuring the height of a stalagmite. It includes keyboard functions such as addition, subtraction, and multiplication, to compute area and volume. It includes 20 memory locations, but has no remote I/O for logging with a computer. An optional telescopic viewfinder is available, but not needed for cave surveying. It is recommended for outside in bright sunlight at longer ranges. In larger passages such as the Big Room of Carlsbad Cavern, it may be necessary to station a person to see where the projected spot is located. Another technique is to place a target paper or plate on the spot being measured. There are instructions included for making a target with 3M Scotch Cal material.

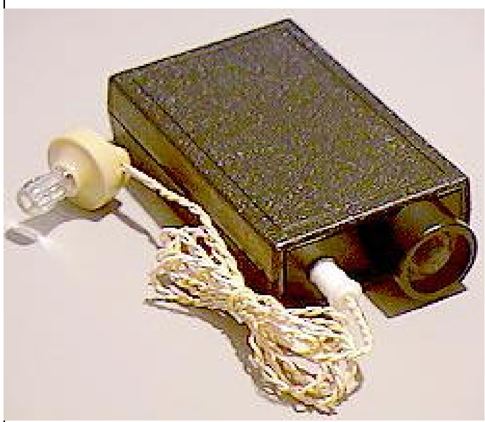
In my 1998 study with the Disto Basic, I was able to shoot a 220 foot measurement in the Lower Cave section of Carlsbad Cavern. While a laser distance meter doesn¹t substitute for setting stations and surveying from point A to B with compass, inclinometer and chain, it is a complimentary tool for sketching, and making one-way shots into passages which are too delicate for cavers to enter. Also, domes, high leads, and pits can be accurately measured without climbing. Several cavers have even modified their rangefinders with protractors, levels and other add-ons, but the hand held Suuntos-style devices will not vanish from cave surveying in the near term. I look forward to using the Leica Disto classic3 to improve mapping. Now, if I could find the right sized Pelican box to protect it.

Build a Simple Bat Detector

Tony Messina - Las Vegas, NV

Ever since my grade school years I've been fascinated with the way a bat uses ultrasound to "see" in the dark. The bat's echolocation skills let it avoid small obstacles, and even catch insects, while in flight. I learned that bats are, ultrasonically speaking, very loud --- so loud, that some of them have special ear flaps that close when they generate an ultrasound pulse so they won't make themselves deaf. I thought something this loud should be easy to detect!

On retirement, I decided to undertake the development of field instruments for bat research. One of the first devices I designed used a simple and inexpensive circuit to make an ultra-portable, personal bat detector. A picture of my original



prototype unit is shown at the left. It is small in size, lightweight, easy to build, and can cost as little as $25 in parts. It turned out to be an amazingly effective circuit so I dubbed it the Simple Bat Detector.

I originally published the circuit for the Simple Bat Detector in 1997. Since then, I've received emails from all over the world, corresponding with many who have built the detector from the information published on this page.

In 1998, I designed a circuit board for an enhanced version of the detector, and started making kits and assembled detectors available for those who had trouble finding parts, or were unable to assemble electronics. I've been thrilled by the many comments of folks who have used the Simple Bat Detector to hear a bats echo call for the very first time.... and have come to admire and respect the bat as I do.

So far, the Simple Bat Detector has found its way to: Australia, Belgium, Canada, the Canary Islands, the Cayman Islands, Costa Rica, England, Finland, France, Germany, Ireland, Italy, Japan, Poland, Mexico, the Netherlands, Scotland, South Africa, Spain, Sweden, and all over the United States.

How the SIMPLE BAT DETECTOR works...

The Simple Bat Detector is a frequency division type device. Frequency division type detectors allow you to hear ultrasonic sound by digitally scaling the frequency down into the human hearing range. For instance, a western pipistrelle bat emits ultrasonic sound in the range of 53 to 91 kHz. If you divide that frequency by 16, the new frequency range is 3.3 to 5.7 kHz, easily within our hearing range. Because the division is done digitally, all amplitude information is lost. Ultrasonic sources processed by the detector convert to sounds like Geiger-counter clicks and chirps.

The basic circuit of the Simple Bat Detector is shown in the schematic diagram to the right. It is essentially composed of 3 integrated circuits, or ICs. The signal from an ultrasonic transducer is fed to IC-1, an LM386 audio amplifier, which is configured to provide a signal gain of 200. The signal is coupled to IC-2, a second LM386, by a .05 uf capacitor. IC-2 is configured to provide an additional gain of 20, for a total system gain of 4,000. The output of IC-2 is direct coupled to the input of IC-3, a 7 stage CMOS digital divider circuit. The input stage of the divider acts as a zero crossing detector, triggering on the negative transition of the signal from IC-2. The divide by 16 output is connected to a potentiometer, which serves as an audio level control. A high impedance ceramic earphone is connected to the output of the level control. The 10K level control is a small printed cir-

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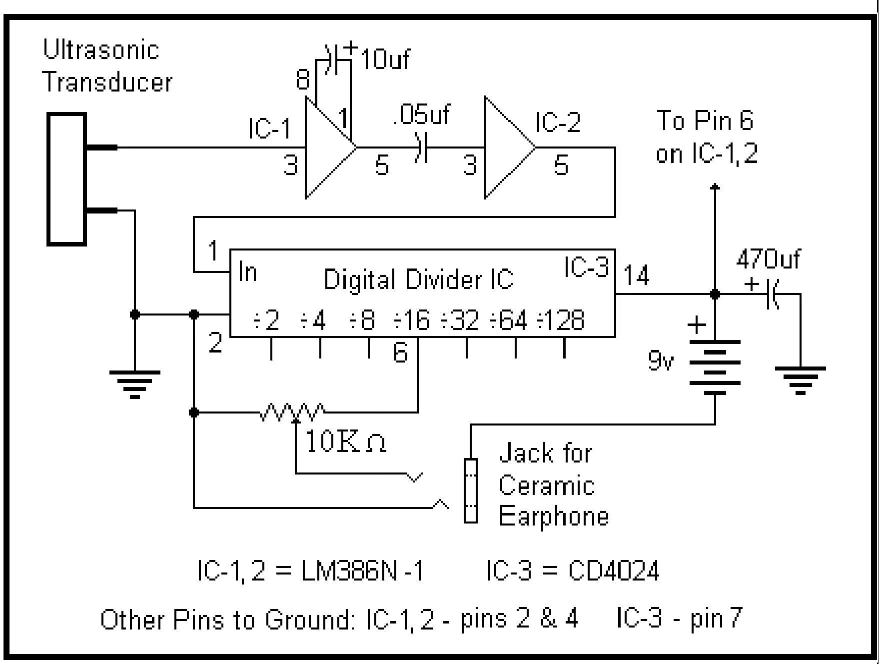

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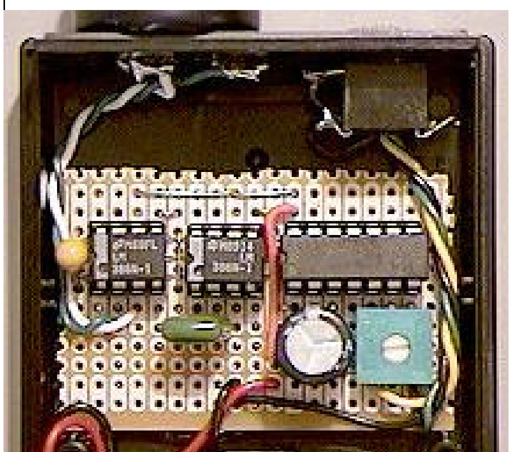
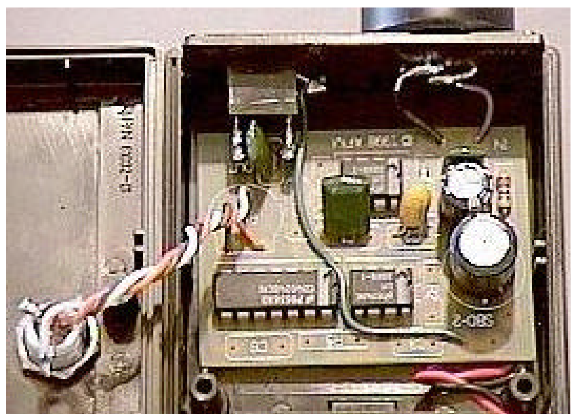
cuit pot that is set and forgotten. The detector circuit is powered by a nine volt battery. (The numbers next to the IC nodes refer to the pin numbers of the IC's. Note the additional pins listed at the bottom of the schematic that need to be tied to ground.)

A major advantage of a frequency division detector is that it is a wide band device ... that means it will let you hear all detectable bat sounds without the need to tune the detector to any particular frequency. Heterodyne detectors, which process ultrasonic sound in the analog domain, only convert a small range of frequencies at any given time - you must select which frequencies to listen to. If you tune up around 60 kHz to listen for a pipistrelle, you may not hear the big brown bats flying nearby. The frequency division detector works in the digital domain, converting the full spectrum of sound that the transducer is able to detect. So you get to listen to all of the ultrasonic sounds around you, without missing anything due to unfortunate tuning choices. I feel this no-knobs-needed characteristic of the frequency division detector makes it a great choice for the casual bat observer, and student.

Building a SIMPLE BAT DETECTOR... Although I have designed a circuit board for an enhanced version of the Simple Bat Detector, it is important to note that the basic circuit shown above is very effective - and parts are available world-wide. Many have built the detector in the same manner as I did with my original prototype - on perf board - as shown to the left. If you don't want to use the perf-board technique, the circuit can always be assembled on the enhanced PCB - as shown to the right. The circuit assembly is then mounted inside the case with hot-melt glue.

The ultrasonic transducer is simply mounted to the front panel by drilling 2 small holes for the transducer pins, and bending the pins over after inserting them through the panel.





Keep all wire lengths short, as very high gains are being generated in IC-1 and IC-2. The picture on the right also shows a method for installing an external volume control, if you feel one is needed. The wiring of the earphone jack is also a little tricky, as it is doubling as the power switch ... so pay careful attention to the schematic above.

In order to accommodate various transducers, you can easily tailor the gain of the two LM386 IC's. An additional resistor can be added in series with the 10uf tantalum capacitor to reduce the gain of IC-1. A resistor / capacitor combination can also be added between pins 1 and 8 of IC-2 to increase it's gain. In this way the total system gain can vary anywhere from 400 to 40,000. Be sure to keep the positive side of the capacitor towards pin #1 on the LM386.

If you have experience in electronics repair or assembly, you can usually build a Simple Bat Detector in a single evening. I will always try to have a supply of circuit boards and components kits on hand for the Simple Bat Detector, so if you have trouble finding parts - email me.

A Printed Circuit Board makes it easy !!!

Having acquired the tools needed to develop circuit boards, I decided to design a board for an enhanced version of the Simple Bat Detector. I took the opportunity to add components that were left out of the original design for the sake of providing easy prototype style assembly. But with a circuit board, I can "flesh out" the circuit. The revised schematic is shown below.

The circuit is basically the same as the original, with the following additions:

Component positions are available to set gains of both LM386 amplifiers (C2, C3, R1, R2)

Capacitive input coupling is provided for (C6)

Capacitive output coupling is provided for (C9)

Power supply isolation components are added for the first amplifier stage (C7, R4)

Standard LM386 stability components are provided for (C5, C8, R3, R5)

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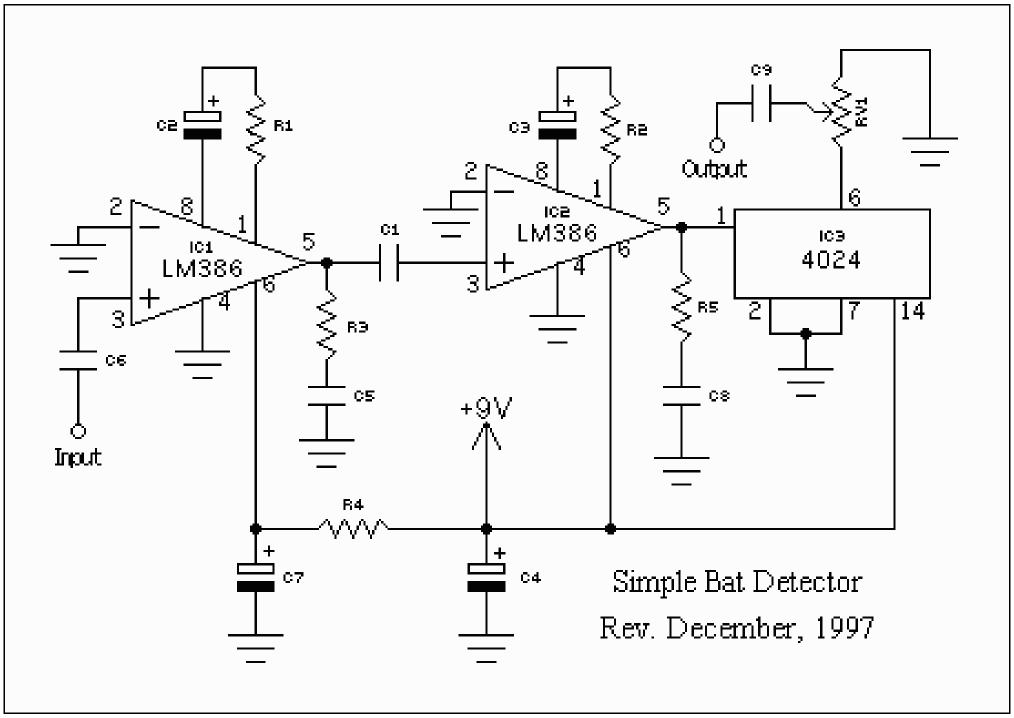


Circuit Designator	Component Value	Purpose of Component
R1, R2	Varies with transducer used	Sets gains of amplifier stages
R3, R5	N/A	Amplifier stability components (not used at this time)
R4	220 ohms	Power supply isolation for first amplifier stage
C1	.047 uf	Signal coupling between amplifier stages
C2, C3	10 uf	Amplifier gain control components
C4	470 uf	Main power supply filter
C5, C8	N/A	Amplifier stability components (not used at this time)
C6	.022 uf	Couples transducer signal to input of first amplifier stage
C7	220 uf	First amplifier power supply filter
C9	.022 uf	Couples detector output to earphone

Standard component values are shown in the table above. The values of the gain resistors, R1 and R2, will vary according to the transducer used. The board has been designed to allow maximum flexibility in the construction of the Simple Bat Detector. A revised cost estimate for building the detector, using the printed circuit board with a full complement of components, would still be less than $35.00. A complete on-line parts list is provided. Part Kits and Assembled Detectors are also available !

Tony Messina - Las Vegas, Nevada - email: T-Rex@ix.netcom.com

First published September, 1997 - Last update: May 17th, 2001

SPELEONICS version July 2001

[**Editors Note**: Please visit Tony's web site for updates and lots of other information about building this detector and for information about kits, parts, circuit boards, or assembled detectors.

The URL is **http://home.netcom.com/~t-rex/BatDetector.html**

Thanks to Tony for allowing the publishing of his web documents.]

A Bat Simulator for Testing Bat Detectors

Paul R. Jorgenson KE7HR NSS 39382 FE

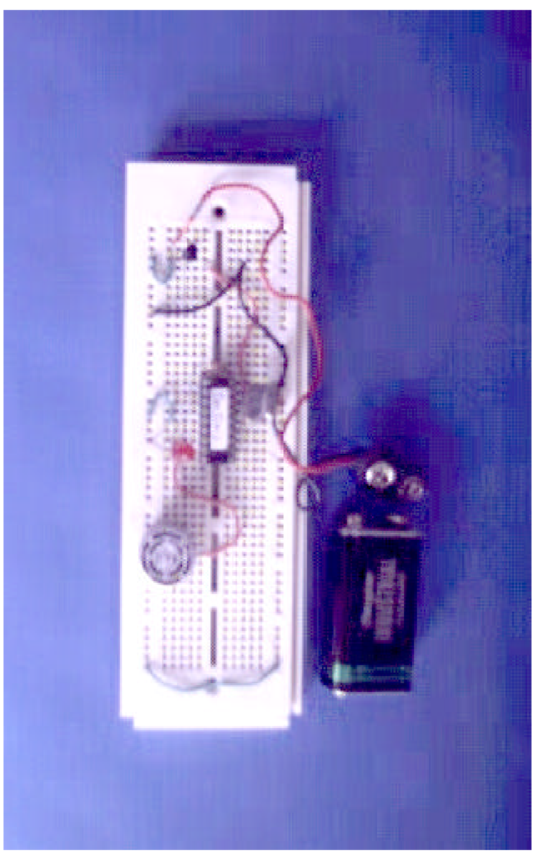
I built a version of Tony Messina's Enhanced Simple Bat Detector from the descriptions on his web pages. While I was quite happy with being able to hear the ultrasonics that this detector put in the normal human hearing range, I had one small problem. How to get a bat to sit still and emit while I was tweaking and trying new component values and other experiments. A handy ultrasonic emitter is literally at hand. By rubbing the thumb and forefinger together, a very good ultrasonic sound is made. Trying to make exactly the same speed and intensity of rubbing while trying out different parts in the design was a problem.

My solution to this problem was to make my own artificial bat! I used a PIC microcontroller and an ultrasonic emitting transducer to simulate the 40kHz tones that bats use. After figuring out the programming to get the 16F84 microcontroller to send the proper ultrasonic signal to the piezo transducer, I kept working. Having the piezo transducer emitting all the time made it difficult to make fine adjustments with a weak signal. The single tone would get lost in the background noise.

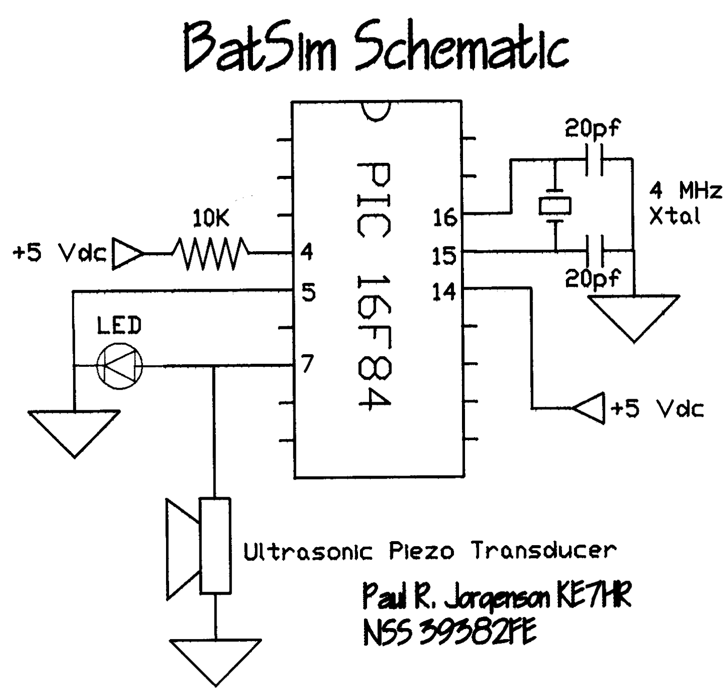
The "Bat Simulator with Morse Code Output" was the next logical step. The 40kHz signal is turned on and off using Morse code. The code helps to identify weak signals while testing the bat detectors at long distances. The Morse code on off pattern is quite easily discernible amongst the background noise. The varying distance from the BatSim to the receiver being worked on while still receiving the signal tells me if adjustments (enhancements?) are working or not. I also installed a LED in the output line to let me visually see the output pulses, which works quite well at night. With my version of the Simple Bat Detector I get a reliable signal from the BatSim over 120 feet (about 37 meters) away.

The PIC I used is 16F84. The 16C84 can be used if some lines of code are changed. The PIC oscillator crystal used is 4Mhz. Other crystals could be used but the software delays would be different. The hardware setup for the PIC is:
pin 7 (port B1) is the output to the piezo transducer and LED from pin 7 to ground; pin 14 to 5 VDC; pin 4 10K to +5 VDC ; pin 5 to ground; 4Mhz crystal across pins 15 & 16; pin 15 & 16 20pF to ground. The PIC is powered by a 5 volt low power regulator running from a nine volt battery. The output piezo transducer I used is a Murata MA40A3S.

Having a reliable signal to test the ultrasonic detectors with has been a great help. The source code for this project is available for non-commercial, personal use. Email me at ke7hr@mindspring.com.



The BatSim Prototype



General Mobile Radio Service & Family Radio Service Information

The proliferation of these small, license free, UHF radios has been a boon to cavers. These little radios are relatively cheap to own and have a short (up to 2 miles) but useable range. Some of the frequencies are shared between the GMRS and the FRS. Many of the radios use tone squelch frequencies which gives the appearance of many more actual communication channels, but there are only 14 separate channels. Except in cases of interference from outside sources, the simple carrier squelch will allow the user to hear if the frequency is in use before transmitting.

GMRS Interstitial and FRS Frequencies:

Channel	Frequency
1	462.5625*
2	462.5875
3	462.6125
4	462.6375
5	462.6625
6	462.6875
7	462.7125

FRS Only Frequencies:

8	467.5625
9	467.5875
10	467.6125
11	467.6375
12	467.6625
13	467.6875
14	467.7125

(*)Many users of the Family Radio Service use channel one for general calling and move off to channels 2 through 14 for conversations. Remember also that the first seven are shared with the General Mobile Radio Service.

Code**	Hz Frequency	Code #	Code**	Hz Frequency	Code #
0	Carrier Squelch		23	146.2	4B
1	67.0	XZ	24	151.4	5Z
2	71.9	XA	25	156.7	5A
3	74.4	WA	26	162.2	5B
4	77.0	XB	27	167.9	6Z
5	79.7	WB	28	173.8	6A
6	82.5	YZ	29	179.9	6B
7	85.4	YA	30	186.2	7Z
8	88.5	YB	31	192.8	7A
9	91.5	ZZ	32	203.5	M1
10	94.8	ZA	33	210.7	M2
11	97.4	ZB	34	218.1	M3
12	100.0	1Z	35	225.7	M4
13	103.5	1A	36	233.6	M5
14	107.2	1B	37	241.8	M6
15	110.9	2Z	38	250.3	M7
16	114.8	2A			
17	118.8	2B			
18	123.0	3Z			
19	127.3	3A			
20	131.8	3B			
21	136.5	4Z			
22	141.3	4A			

**Tone codes are proprietary and are not consistent among all radio brands. The tones above are Motorola, which is the radio type used by the majority of cavers so far.

ANOTHER NEW GIZMO I CAN'T DO WITHOUT

(from SW Cavers, V.39, No.2)

That does it. I gotta' get one of those new cave finders. I'm tired of ridge walking up and down each side of that canyon, sticking my head into every rabbit hole, and finding no caves that I can climb into. I just got my new Kellyco catalog. They're that metal detector super store, at www.kellycodetectors.com. Heck, they got this LASERSCAN DIS600 Pro. Says it uses laser guided technology. Something from Los Alamos I suppose. It recognizes that all objects having temperature radiate infrared energy. Hmm. I'll quote what the catalog says as it's too technical for me: "This energy travels in all directions at the speed of light. Objects store and dissipate this energy in different concentrations. For example: If a treasure were hidden in a cave on the side of a mountain and the mouth of the cave was filled in, the treasure would be hidden from sight [that's real sharp thinkin']. However, when an infrared scanner is pointed at the side of the mountain, it can read the typical surface temperature. The trapped air in the cave keeps the mouth, even though covered, slightly cooler and this difference is detectable.... Use laser guided infrared scanners to locate physical treasures, caves, tunnels, mines, wells, etc." The 600 Pro has MX technology, with 16 lasers. Yep, I knew it, star wars technology. How much is this jewel? Only $1300. Must be a bargain considering what the government paid to develop that stuff.

Then again, I could settle for a standard two loop metal detector, the Treasure Baron TF900. The ad says "automatic with dual frequencies will now locate caves and voids!" "...even the novice can find hidden caches, caves and old wells with ease." Damn, its only $489. I gotta' have one. Watch out, new caves out there waiting for me to find you!

John T. M. Lyles

LED Caving Lamp Development & Use

by Pete Shifflett 21467RL(FE) Pete@The-Cavern.com

There will be many different uses for LED lighting by cavers. Station markers, emergency flashlights and instrument illuminators are just a few applications that LEDs have commonly been used for over the years. Now, recent advances in solid-state LED/phosphor technologies has made primary LED caving lamps a practical and decidedly advantageous alternative to incandescent lamps. There can be little doubt that LED technology will soon be the preferred lighting choice among the majority of cavers. Over the past couple of years I've built ten such white LED lamps designed specifically for use by cavers on long remote caving expeditions. This is a description of these lamps.

Development and use

In designing a primary LED caving lamp, at least all of the following factors need to be considered:

* Battery weight and volume
* Battery electrical characteristics
* LED efficiency
* LED lifetime
* Power converter efficiency
* Robustness

For caving that involves long continuous underground use (weeks or more at a time) in very remote areas, it's best to try to optimize Burntime*Brightness/Weight. This dictates the use of lithium batteries, high converter efficiency, and high LED efficiency. Typically, the weight penalty of bringing a backup primary lamp cannot be tolerated, so the lamp had better be bomb proof.

One of the design requirements for my white LED lamp was that power would be supplied from a single lithium D-cell or by two alkaline D-cells. This meant that I was forced to use an efficient boost current regulator. I also decided to run the LEDs (lamp at full power) at about 13.3mA instead of the usual 20mA. This provides for good LED efficiency, very long LED lifetime and means that I draw only about 1.2 Watts from the batteries (25LEDs x 0.0133Amp x 3.4Volt / 0.92 efficiency). Pairs of alkaline D-cells are quite happy at this power drain and will gladly produce full power for 17 or 18 hours continuously. They become increasingly unhappy if you try to run them at substantially higher drain. The neat thing about LEDs is that they become more efficient at lower currents so there is only a small decrease in brightness when running them at somewhat reduced current levels. Overdriving fewer numbers of LEDs at higher currents is a loosing game.

Details

My LED lamp uses an array of 25 white Nichia LEDs. I use a very efficient step-up switcher (Maxim MAX1703) powered by anything from about 1 to 3 Volts or so. I prefer to use either a pair of alkaline Ds or a single lithium D, which I mount on the back of my helmet. I include a 0.1W current sense resistor and an op-amp in the circuit in order to convert the MAX1703 into a constant current regulator. By selecting op-amp gain I can run my lamp at full current (333mA), half current (167mA), or 1/10 current (33mA). Since I drive the LED array in parallel, and because NICHIA LED forward voltages vary quite a bit, I decided to use a small ballast resistor (~10W) for each LED. I measure the forward voltage of each LED using a 13.3mA current source. Then I calculate the appropriate resistor values that will perfectly

(Continued on page 22)

(Continued from page 21)
balance the current through the array. On the other hand, if you have a large batch of LEDs to choose from you can usually select 25 of them that have about the same forward voltage. In this case, you can eliminate the ballast resistors altogether and recover about 4% lamp efficiency.I designed a circular two-sided circuit board with the LED array, the SMT inductor, and a few caps on one side, and all other SMT parts on the other. I wasn't happy with any of the commercial lamp housings so I machined my own housing from 6061 aluminum alloy tubing 2.25" OD, 1.75" ID, 1.30" long. The circuit board is inserted from one side where it rests upon a step. The other side of the tube also has a recessed step on which is epoxied a 1/8" thick, 2" diameter borosilicate window. The window is recessed into the housing by about 1/4" in order to reduce chances of breakage.

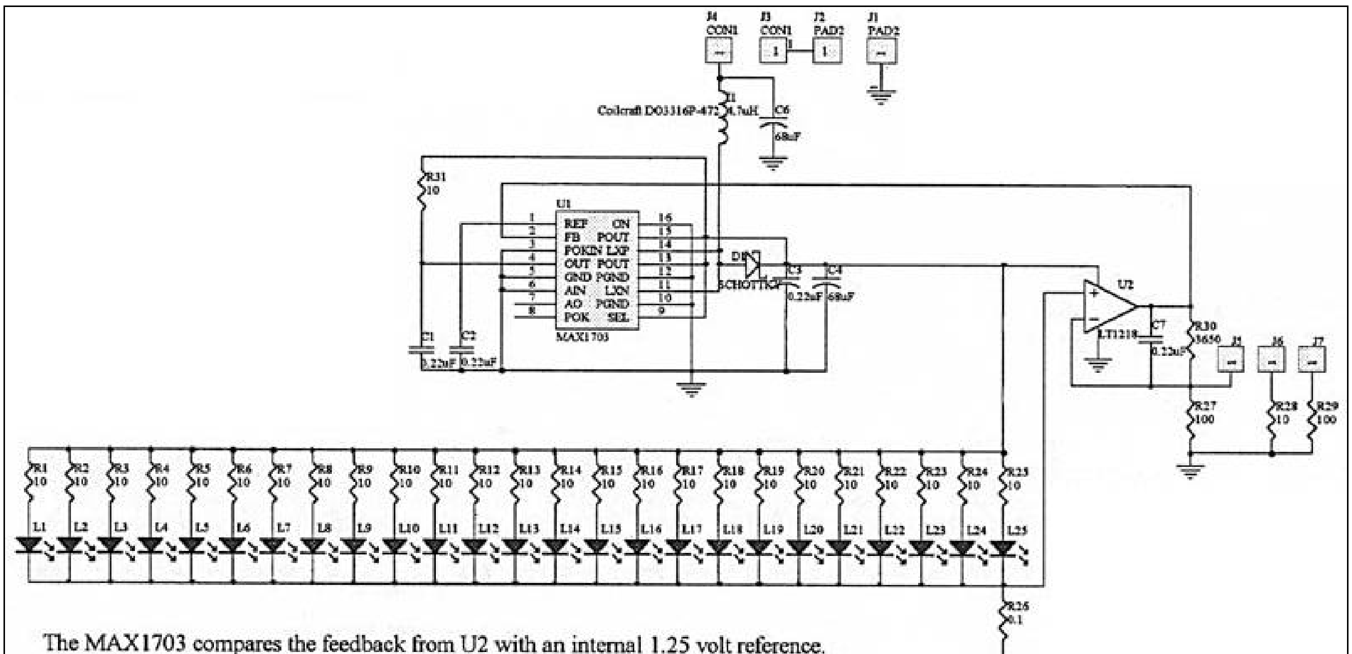
The backside of the housing (circuit board side) has a pair of toggle switches - SPST for power, and SPDT (on-off-on) for power settings. The switches protrude from the lower side of the housing and are protected with watertight switch boots. The entire back side of the lamp is potted with a marine epoxy. Two 1/4" diameter stainless-steel standoffs, used for power input and mounting, are screwed to the circuit board and protrude through the back of the potting material by about 1/8". For helmet mounting, I machine pivoting mounting brackets from Delrin with heavy brass spades.

Alternative Circuit

This is actually my second go at a robust LED caving lamp. My first lamp consisted of 25 of HP's very bright amber LEDs in a housing similar to the one described above. The low forward voltage of these LEDs means it is actually most efficient to use a linear current regulator to drive the array from batteries producing between 2.2 to 3 Volts.

I built an ultra-low-dropout linear current regulator (~60mV at 1/2 Amp) using a low on-resistance, low gate-voltage power MOSFET. A 0.1W current sense resistor feeds an inverting micro-power op-amp, which drives the gate of the MOSFET in its linear region. A regulated charge-pump is used to supply the op-amp and to provide a rough voltage reference.

This linear circuit has some nice advantages over a switching regulator: Simple protection from reversed battery insertion and excellent end of battery life characteristics. When the battery voltage eventually drops below the LED forward voltage (+ regulator dropout voltage), the LEDs very gradually start to dim. With a pair of alkaline D-cells, you get about 20 hours continuous full power burn time, with about 8 more hours of dimming but usable light. The same circuit could be used with white LEDs but it would be necessary to use a 4.5 Volt battery system.



The MAX1703 compares the feedback from U2 with an internal 1.25 volt reference.
R30 is selected to give a gain of 37.5 which will produce 1/3 amp through the LED array.
An ON-OFF-ON switch connected to J5,J6,J7 selects Full, Half, or Tenth power.
Select R1 - R25 so the current through each LED is balanced at 13.3 ma each.

White Lightning

For a large (300 kb) view of the schematic, please visit :
http://nerve-net.zocalo.com/jg/c/tech/Led/Shifflett/Shifflett_LED_Schematic_Full.jpg

Remote Cave Cameras

by John T. M. Lyles

I lost ROCK (Remote Operated Cave Kinescope) in the Wonderland passages of Cottonwood Cave, NM a few years ago. I had reported on it at the Blacksburg NSS Convention about 5 years ago. It is still there, lying deep within a crack. The mistake I made was to use aluminum rods for the extension poles. They were surplus lab stand rods, and I drilled and tapped each end to 1/4x20 US thread. With the addition of a bit of cave dirt, the threads seized up and then wouldn't screw together tight. At one point, I neglected to torque one of the 18 inch extension rods and the rig was out at about 15 feet long. When I lowered it into this potential new passage, it snapped off at the exposed thread. The camera, which was IR illuminated B&W CCD module inside a Pamona box, fell and ripped the coax/power cord away. So I pulled out a stub without camera. The VCR is a 8mm Sony model with built in LCD viewer (not digital, not even hi8, it was a hamfest bargain NTSC unit).I had to tape a few holes to keep the dirt out, and now keep it in a baggie in my pack.

So far, I have been unable to convince the US Forest Service to allow me to break open the crack and climb down to this virgin passage to retrieve ROCK. We have made trips to the lower levels of the same cave, to try and climb up to where it might have been but cannot reach that point yet and it is quite exposed in the cracks dozens of feet above the floor.

BUT, before ROCK was lost, it proved to be extremely worthwhile. In four examples, I probed it into cracks that had air blowing, and found open passage beyond, which encouraged us to continue pushing. I have a collection of wonderful but boring videos of each push. One addition which I added was a microphone at the VCR, to record a soundtrack at the time of what we were pushing into. I never did add a built in 'on screen' fluxgate compass readout, as it would have cost too much for me (and I would have really cried in my beer to loose it with ROCK). However, I now see that some down hole well cameras have compasses, which are nothing more than a cheap hand compass mounted in front of the lens, before the side mirror.

Here is a link to a costly commercial down hole well camera, also known as a borehole camera. It has an interesting example on the photo gallery page, of picking up a lost camera at -400 feet down a well into a cave passage:

http://www.marksproducts.com/

For a bizarre and stupid usage of an underground camera, there is the Mystery Hole link:

http://www.europa.com/edge/mystery.html

ROCK II is being built to be down-hole, and also stick-extendible. I bought one 18 foot bungee cord tent pole from REI, which is much lighter and easier to fasten than my rods. (Duct tape should prevent the sections from slipping loose when in use). I checked Marshall Electronics, Polaris Industries, MicroVideo, and Supercircuits for CCD modules. Supercircuits (http://www.supercircuits.com) appears to have the best prices I could find for B&W camera modules that are even smaller than what I used in ROCK. The color cams have not have the low light sensitivity required. Besides, B&W (monochrome) will be very sensitive to the IR and red LED's which are cheap and easy for illuminators (ROCK had a ring of both LEDs). CMOS imagers are cheaper than CCD's but don't have the sensitivity. They do have the advantage of lower power consumption, making the camera work on a 9 volt cell. I got the Marshall V1215T which has the capability to drive a thousand feet of cable and has a regulator built in. See it at:

http://www.mars-cam.com/osd/cameras/case-bw/v1215.html

The voltage range is 7.5 - 14 VDC at about 110 mA of current. It has a 1/4 inch 380 line resolution CCD. Sensitivity is 0.4 Lux. I got it from a vendor on the web for about $69. Supercircuits now has the same or similar units for sale.

Lessons I learned from ROCK

The twisted pair, to carry the video, must be very strong or have a secondary pull line. For down-hole applications such as hanging from a cable in a well, the losses for baseband video need to be weighed against the ability to use a VHF channel (56 MHz range). VHF would allow me to use the TV set tuner as a receiver, a 'free' low noise amplifier. Putting the gain up top makes sense from a payload standpoint. However, the signal to noise would be best with the power amplification 'downstairs¹. However, the V1215 has the video drives on board for baseband. It¹s a very compact nice camera module.

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So, sticking this on the end of my tent pole with a some tapped holes in the aluminum end cap wasn¹t difficult. It is somewhat more fragile than ROCK, which was mounted in a Pomona Box with a clear polycarbonate cover to see through. ROCK II is naked, but it is also very small and flexible. For illumination I have three high intensity red LEDs mounted on perf board, pushed around the lens housing. I bought the lens version instead of the wider angle, more distorted, pin hole version. There are some lithium cells taped in a "blob" hanging on the pole just under the camera. These two AA sized cells are enough to power the LEDs separate from the camera DC. I power the camera as I powered ROCK, with a Justrite battery holder (red plastic) and four D cell lithium batteries from SAFT. They are high current, so I have a Polyfuse protector in the package. The video and power come down a three conductor, shielded, twisted pair that just drapes along the tent pole with rubber bands or duct tape - nothing fancy or even pretty.

Using the same beat up SONY 8mm Watchman VCR, I have probed a few cracks and holes so far this year, and have great results on tape. I am presently downloading to a Quicktime movie to email to my comrades who push with me. I'm looking forward to opening up Lechuguilla II with the assistance of ROCK II.

Not Another LED Headlamp Miracle

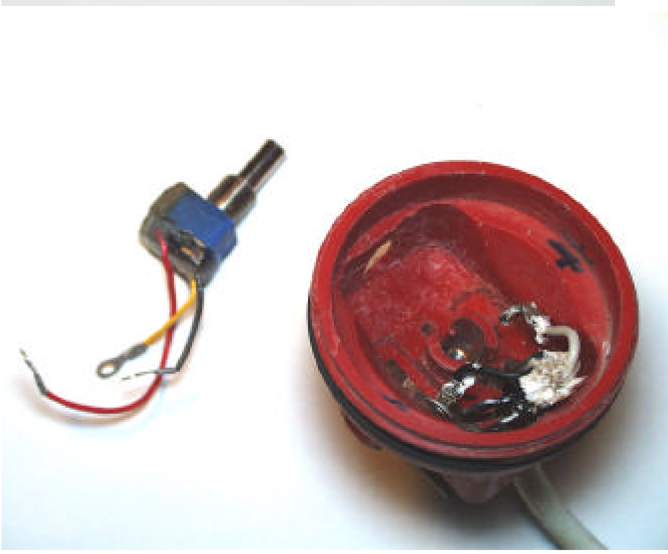
John T. M. Lyles, NSS 19871

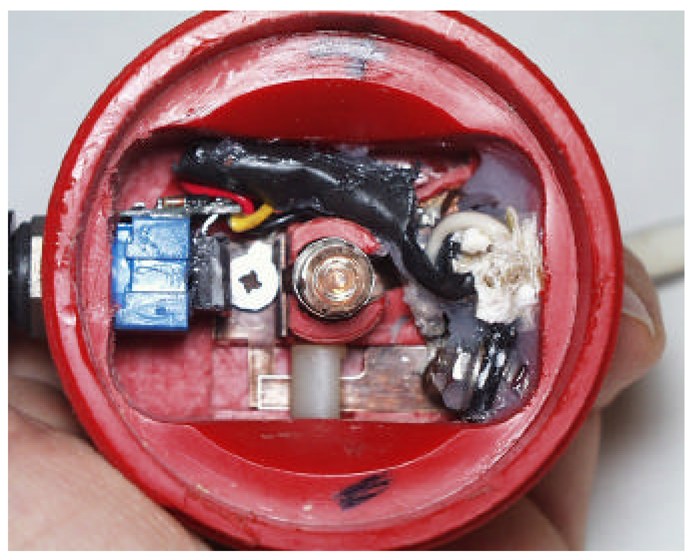
Problem - Battery Weight

- Multi-Day expeditions required 8 to 12 D cells for my 2.5 Watt Halogen bulb
- 35 hours of life on Duracell D's
- Each cell weighs about 5 oz, new or spent
- 3.7 lbs of pack weight used for 84 hours light (week), leaving 8 dead cells, 4 partially spent

Solution - Install Dimmer

- New tiniest CMT model, fits inside lights
- Only use light you need, at all times
- Prevents bulb burnout on turn on
- Nov. Lech, 4 day trip, 4 cells!





Left: Cave Man Technology * (Jim Sturrock) dimmer with milled-out Roosa-Lite

Right: Interior of Assembled Light - Eliminated the spare bulb space

*Dimmers are available from Jim at sturrock@cybermesa.com or through Inner Mountain Outfitters. He has two versions, one which regulates, and one which is a raw dimmer. I used the latter, since it is so compact.

Message from the Chairman

Our annual meeting was well attended at the Kentucy NSS Convention, on July 23, 2001. The classroom overflowed with interested cavers and electronics enthusiasts. The photo shows electronics enthusiast Doug Strait raising an excellent point about LED power sources. Our business meeting acted on several agenda items which have carried over from the past two to three years. You are reading this PDF version of Speleoincs due to the decision to proceed in this manner. Read the minutes to see what I mean.

Its good to see that we have gotten some momentum to proceed on publishing again, in an appropiate electronic fashion. Its up to all of us to support the effort and submit letters, articles, comments, circuits, announcements, and reviews. Its up to me to keep things rolling this year, so that we can get past the logjam that nearly killed the section; We will strive to again be the premier forum for the latest in cave technology via electronics. We have plenty of support and encouragement from overseas also, and there is synergy in the air (or ground?). We don't want to kill off innovation - so lets start by writing and talking about what you like to do.

jtml [K5PRO]

2001 ANNUAL MEETING MINUTES:

Our annual meeting was well attended at the Mt. Vernon, Kentucky NSS Convention, on Monday, July 23, 2001, from noon until 3 PM. The room was overflowing with interested cavers and electronics enthusiasts.

John Lyles (Chairman) opened the business meeting after lunch. Brian Pease (Secretary) read last years minutes, which were accepted as read. Joe Giddens (Section Treasurer) gave the treasurers report. He said there was $1468 in the treasury with no expenses outstanding. The late Frank Reid held a number of checks without cashing them, as far back as 1994. We all agreed to re-start records with the current amount. A sign-up sheet was circulated to gather current address and email info.

Joe is looking for Frank Reid articles for issue #22, which he is editing. He brought all Speleonics back issues to the meeting (and the consignment shop) for sale at $1 each. He also brought a member list showing how many issues each person had paid for in advance, and an address list sorted by zip code, which is getting out of date. There are quite a few foreign addresses and several free copies to NSS, etc. Our work is now to refine the address list, and get updated addresses and emails for everyone. Joe suggested that we update the mailing list as best we can and then mail out the next issue of Speleonics.

A show of hands indicated that nearly everyone has email now, and could receive it electronically.

Gary Bush (who manages our website) has posted a long list of useful links given to him by John Lyles.

John Lyles showed a draft copy of issue #23, which is being guest edited by Paul Jorgenson. It is in PDF format for Web posting, and is ready to "go to press" or online, after the meeting and minutes are included.

There was a discussion of electronics vs. hard copy publishing: Comments were solicited on the ideas brought up at last years meeting, specifically to consider sending out Speleonics electronically. Several members continue to desire paper copies in the mail, although the majority felt that an electronic copy would be acceptable. Dave Larson discussed the real costs and drawbacks of bulk mailing. He had worked on Windy City Speleonews which had a
large mailing list. He explained the hidden costs of bulk mailing (including the minimum quantity, address change response problem, and so forth). It was decided that first class would be acceptable when so many potentially incorrect addresses are on file.

John Lyles suggested that the next issue could be mailed first class to help update the mailing list, and to poll members about electronic vs. hard copy publishing.

One suggestion made by Ray Cole was to eliminate dues completely, as the section has almost no ongoing expenses, and publish on the Web openly, without passwords, in PDF, for anyone to read or download. An officer would mail a few printed copies to the NSS Archives, etc., and to anyone requesting them, for a fee covering printing and mailing.
This brought up much discussion, and everyone was favorable about a free membership. Ray stated that he may be paid in advance for many years, but would not mind just writing off this expense to simplify the operation of the section. After all, our real goal is not to make money or have expenses. It is to disseminate timely and useful information on electronics and other technologies that can improve and enhance caving.

John Lyles brought up the problem of editors. He suggested that guest editors would continue to work as long as someone would go through the process of creating the PDF file. A discussion was held of PDF vs. HTML formats and the virtues of each. John expressed the opinion that HTMLs are not so universal to print what you see on the screen. Often he gets graphics stuck in the middle of text, an unreadable mess. It depends on the web browser and setup. PDF, while requiring more work up front to create, is nearly universal for the more common PC platforms from Macintosh to Windows.

Dave Larson made a motion that the next issue of Speleonics (Paul Jorgenson's issue) be published in PDF on the Speleonics Website, and announced on the Speleonics email list. People will be requested to email with updated address info and state whether electronic copy is OK. This passed without opposition.

Joe Giddens will be continuing to develop the Frank Reid Special Issue, probably #23 and requests articles.The latest issue by Paul Jorgenson will be #22 now to prevent further confusion as it comes out first. We must ensure that the articles sent to Joe and also to Paul don't get repeated accidentally.

Ray Cole said that a committee should be set up to propose a new dues structure (or none) and any necessary changes to the constitution and Bylaws. This was approved and the 3 officers will handle it. Joe Giddens has the Constitution and bylaws. We will work with him to consolidate and modernize our bylaws to reflect the direction we are headed.

Elections were held. The 3 officers were re-elected without opposition. They are: John Lyles, Chairman; Brian Pease, Secretary; and Joe Giddens, Treasurer.

Business meeting was adjourned about 1:45 PM so that the technical presentations could commence.

TECHNICAL TALKS:

Ray Cole gave a talk on an adjustable switching regulator for a 24 white LED series-parallel LED array. Ray also talked about another version of an LED lamp he made.

Brian Pease gave a talk on an adjustable linear current regulator for a 24 white LED array, and also showed a tungsten bulb regulated 3-LED flashlight. He showed an inexpensive Li-S primary battery pack that is military surplus and available from Fair Radio Sales in Ohio. A sample was passed around for show and tell.

John Lyles showed a Petzl Tikka as representative of 3 LED backup headlamps. He proposed modifying it to add current regulation, for constant light output until the battery dies, like what the Princeton Tec LED module does. He will probably use Doug Strait's regulator circuit using a surface mount LM334 current source and a Zetex low Vce(sat) bipolar. A comparison of burn times and brightness will be needed for the Tikka and the modified Tikka.

Since electronics are becoming harder to find in DIP and larger packages, John showed some helpful surface mount tricks. One was the SURFBOARD, a small inexpensive printed circuit that allow prototyping surface mount ICs and parts. They can be found at DigiKey. Another was the Express PCB layout package available online for free. A small board can be made using the free software for about $50 and all done online.

John Lyles gave a talk on filament (Edison) bulb specs. Not for the LED techkies, he "focused" on screw and flanged base incandescent (krypton and halogen also) bulbs for many of the inexpensive lamp headpieces. An updated chart comparing the choices was presented.

John talked about his ROCK and ROCK II mini video camera systems. ROCK was lost in a crack several years ago, but ROCK II now uses a shock-corded tent pole and an even less expensive and smaller CCD camera. A video was played which demonstrated some results from both models shot in caves and digs.

There was a general rag-chewing period after the presentations where those present spent time talking about circuits and playing with various devices and lamps that were brought to the meeting.

Most of the papers will be reprinted in color in the upcoming edition of Speleonics, #22.

Brian Pease gives a talk at the 2001 Convention Section Meeting.