A Self-Contained “67.5 volt B Battery” for Portables
by Tony Maher

This article describes the construction of an AA battery powered 67 1/2 volt “battery”. This new rechargeable “B battery” is slightly smaller than the original Eveready 467 battery and is the same weight. The substitute battery can be made in different voltages and can be powered from a wide variety of sources.

Warning: *this unit generates voltages which can in some circumstances be lethal. Take all precautions*.

The immediate forerunner of today’s transistor portable was the Personal Portable of the late 1940’s and early 1950’s.

Many of these were very attractive sets. They used miniature 7 pin valves and were powered by small Eveready 67 1/2 volt batteries, but they were expensive to buy and to run.

With the advent of the transistor radio in the late 1950’s they disappeared from common usage and sight.

Today the small 67 1/2 volt batteries that powered these sets are no longer available and the collector has the choice of soldering together seven or eight 9 volt batteries or making a mains powered power supply.

Neither choice is a good one.

The first at about $30 to $40 a time is expensive, and the second takes away the portability which was one of the major attractions of these, the smallest valve receivers ever made.

A year ago, during a visit to the hills around Melbourne, the writer obtained a small cream AWA Personal Portable Model 450-P made in 1948.

This radio uses two D flashlight cells for its filament supply and a small 67 1/2 volt Eveready 467 battery for the B supply.

D batteries are, of course, readily available but not so the B battery. This focused the author’s mind on a suitable B battery replacement.

I sought out on the internet a suitable design. I found many mains powered battery eliminator designs and a few suitable battery powered ones for portable use, but none that fitted inside the set in the place occupied by the original battery.

The final effort was to design my own.

This was not a simple task.

I wanted a simple solution that did not involve metalwork or shielding, that was easy to make, cheap to build and run, and could of course happily coexist with and within a small valve portable radio.

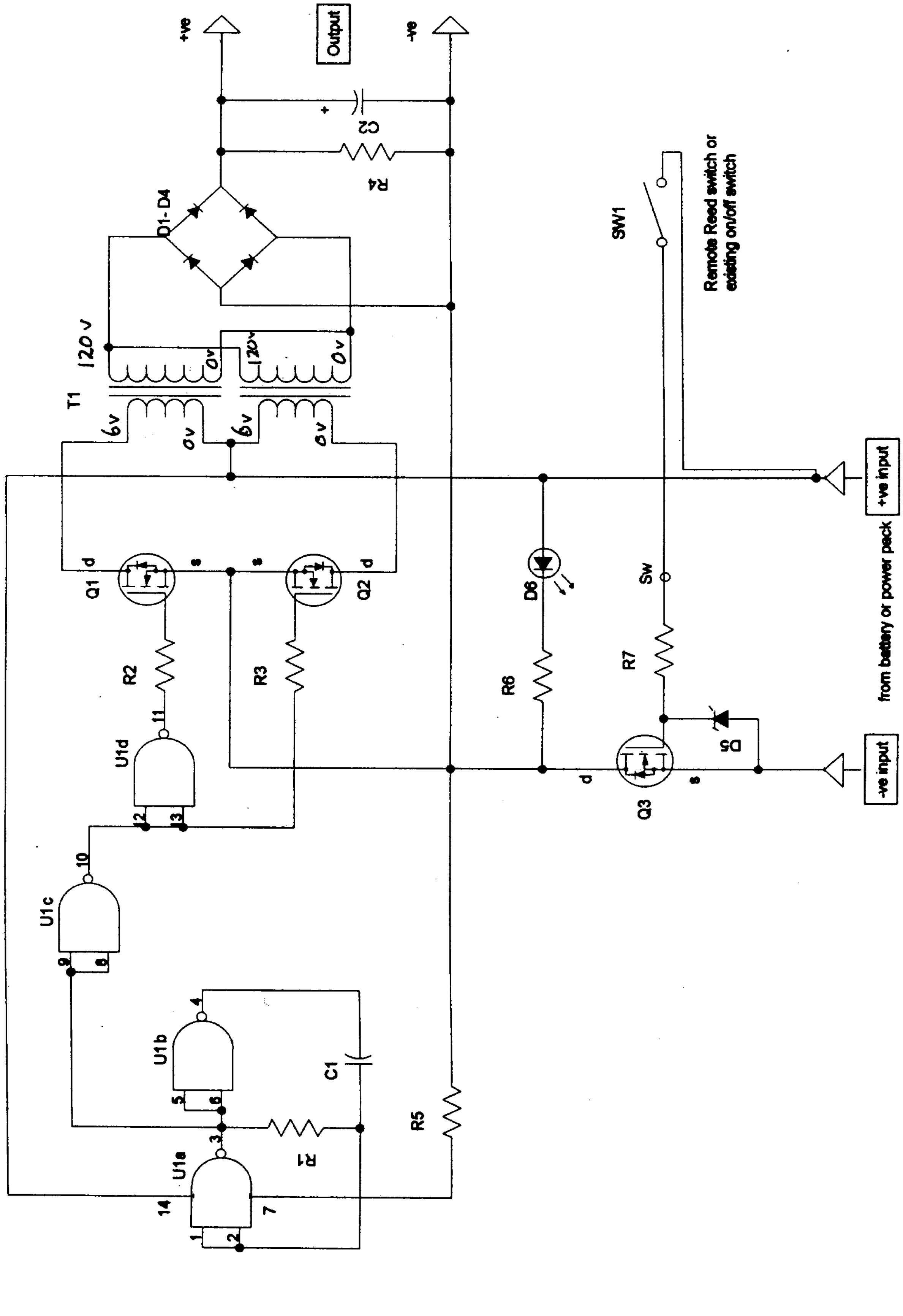
Switching regulators could be used but the author’s experience of these in the past had shown him they were a potent source of Radio Frequency Interference (RFI). Cast aluminium boxes, filter chokes and miniature metalwork loomed on the horizon.

Luckily the space requirement ruled out this approach.

Once the switching regulator approach had been discarded a 50 hertz inverter was considered. The lower frequency would make RFI problems much more manageable and ordinary power transformers could possibly be used.

Serendipity then entered the scene in the form of a magazine advertisement for “on special” 10VA toroidal power transformers . These were cheap at $10 and they had two 6 volt, and two 120 volt, windings. Toroids are efficient, small, and have very low external fields. I ordered two. Oh how I wish I’d ordered more....

CIRCUIT OF THE 'B BATTERY'



the price has now more than doubled....
This transformer forms the basis of the final design.
Power is supplied from 4 or more AA NiMH batteries, depending on the output voltage required.
Other power sources that can be, and have been, used include AA alkaline batteries, AA NiCad batteries, lead acid batteries, non regulated voltage adjustable power packs, and regulated voltage adjustable power packs.
Personal Portable radios were designed to operate over a wide B battery voltage range. Batteries were expensive and the radios were designed to extract the maximum amount from the battery before it was discarded.
Typically radios were designed to continue operating with B battery voltages 30% or more below their nominal voltage.
This unit will continue to operate when the individual AA cells are below 1.0 volt. This corresponds to an output voltage of 40 volts.
A set of four AA NiMH 1600maH rechargeable batteries will supply the B battery needs of the authors AWA 450-P Personal Portable (67 1/2 volts at 8.0ma) for nearly 10 hours at a B battery cost approaching zero (assuming of course you already have the batteries).
The unit will give 15 hours or more of operation from a $2.50 set of Chinese made AA Alkaline batteries.

PARTS LIST

C1 Capacitor 330nfd MKT type
C2 Capacitor 100mfd 160 volt small or
Capacitor 47mfd 250 volt small
D1 - D4 Diode 1N4007
D5 Zener Diode 1N965 15 volt
D6 5mm Red led of reasonable brightness
Q1 - Q3 Mosfet MPT3055E
R1 Resistor 15k ohm 1/4 watt
R2 - R3 Resistor 100k ohm1/4 watt
R4 Resistor 470k ohm1/4 watt
R5 Resistor 100 ohm 1/4 watt
R6 Resistor 1k ohm 1/4 watt
R7 Resistor 10k ohm 1/4 watt
SW1 Reed switch normally closed type.
This is used as an on off switch for the unit.
A small Dip or microswitch can also be used.
An existing B battery switch on the radio can also be rewired to perform the function.
The existing B battery wire from the switch should be directly connected to the +ve output of the unit.
WARNING. Take care when rewiring an existing switch. Do not under any circumstances connect the output of the unit to the A battery or filament circuit. Valves will be destroyed if this occurs.
T1 Toroidal Transformer 10VA Powertran M4312
Two 6 volt windings plus two 120 volt windings.
Available from Altronics Perth or Elstronics Christchurch.
U1 IC Cmos 4011BP
Also the following hardware:
Battery holder suitable for 4 AA batteries (or more if higher voltages are required.)
Doublesided tape or suitable glue for mounting the battery holder to the transformer.
Polycarbonate or similar insulating material for forming into a U shape to insulate and protect unit.
3/16" screw for mounting same to transformer
Suitable Nickel Metal Hydride, alkaline, Nicad or lead acid batteries.
A printed circuit board for the unit has been designed and is available from the author.

The unit can be used with extra AAs as a 90 volt battery or as a 108 volt supply. With a switchable 1 amp plug pack it can be used as a variable bench supply.
Note 1: An Eveready Type 467 MiniMax 67 1/2 volt battery is 94 x 71 x 35mm.
An Eveready Type 482 MiniMax 45 volt battery is 140 x 89 x 44mm.

Circuit operation.

2 parts of a Cmos 4011 quad nand gate U1a and U1b are used as a square wave oscillator. The frequency of the oscillator is not critical and is set by the capacitor C1 and the resistor R1.
Another nand gate U1c is used as a buffer between the oscillator and the gate of a Mosfet Q2.
The last nand gate of the 4011 U1d is used to supply an inverted signal to the gate of another Mosfet Q1.
When its gate is driven positive by the buffered output of the oscillator each Mosfet in turn passes current through it’s portion of the primary of transformer T1.
The transformer steps up the voltage and supplies it to a bridge rectifier D1- D4 and filter capacitor C2.
Because the voltage from the transformer is a square wave, with only a small time between each

half cycle, there is little ripple on the output and only a small filter capacitor C1 is required. R4 discharges the capacitor C1 in the event of there being no load connected.

The toroidal transformer has two 6 volt windings which are connected in series. These are driven by the Mosfets.

It also has two 120 volt windings which are connected in parallel.

Resistors R2 and R3 perform a number of roles and should be located as close as possible to the gates of their respective Mosfets.

Their first role is ensure that one Mosfet is off before the other turns on.

They do this in conjunction with the gate to source capacitance of each Mosfet by slowing the rise and fall times of the square wave which is fed to each Mosfet.

They also minimize the amount of RFI generated and prevent high frequency oscillations from occuring in the gate circuit.

Resistor R5 prevents destruction of the 4011 I.C. in the event of the battery being connected the wrong way around.

R6 and D6 provide a Power on light for the unit.

Q3 acts as an on/off switch. It enables the unit to be turned on and off by a small current. A normal toggle switch can be used in its place but it is often desirable to have switching performed by small low current contacts.

Low current reed switches can be fitted to doors lids etc. so that the unit turns on automatically when a door or lid is opened. Reed switches would stick if used to directly switch the current required by the unit.

D5 and R7 are used to protect the gate of the Mosfet from being damaged by static.

Experienced readers will have noted that this circuit is very similar to that of the Vibrator power supplies long used for battery operated radios and car radios. The plugin vibrator unit is replaced by the 4011 and the two Mosfets.

The 4011 oscillator acts as a replacement for the vibrator's reed and the 2 Mosfets act as the vibrator's contacts.

The author is currently adapting this design to act as a plugin vibrator replacement.

Mechanical construction

The unit is built around the toroidal power transformer. The power transformer is designed for printed circuit mounting and advantage is taken of this to mount a small fibreglass matrix or printed circuit board to the pins of the transformer.

All components are in turn mounted on this board. The battery pack is fastened to the flat side of the transformer with double sided carpet tape or Scotch VHB tape or similar.

Clear 1.6mm thick polycarbonate plastic is cold folded into a U to create the correct size envelope for the "battery" and to provide insulation.

This envelope is held in place with a 3/16" countersunk screw which passes into the central mounting hole of the transformer.

Please refer to the photo and layout drawing.

Assembly

A printed circuit board has been designed for the unit.

This is a small board and the tracks on it are likewise small.

You will need a suitable soldering iron with a suitable tip. A Scope or similar high wattage soldering iron will not do.

A 25 watt or temperature controlled iron with a small tip is required.

Insert components in the position shown on the drawing. Insert Mosfets last.

Leave Mosfet leads at maximum length.

Refer to the photo as necessary.

All diodes and all resistors are mounted vertically because of limited space.

Observe the way each component is fitted in the photo and copy.

Test pins are fitted on the perimeter of the board and the input, output and switch leads are soldered to these pins.

Note: One switch lead shares a common pin with the + input lead.

There are four wire links on the board. One link runs along the top of the IC.

The other three links are on the copper side of the printed circuit board.

Join pads labelled A to A, B to B, C to C and D to D.

Testing

Warning: this unit generates voltages which can in some circumstances be lethal. Take all precautions.

Care should be taken with the wiring to ensure it is as per the circuit diagram.

Great care should be taken to avoid shorts and dry joints.

Buy new glasses if necessary.

Visually check and check again.

Is the polarity of the electrolytic capacitor correct?
Is the IC or one of the Mosfets around the wrong way?
Note the Mosfets. One is reversed in orientation to the others.
Are the 4 diodes the correct way around?
Does the bar on the zener go to the outer edge of the board?
Do you have the correct resistors in the correct places?
Check your colour codes.
Make sure the transformer is the right way around. 6 volt windings should be near the Mosfets.
Make sure each individual AA cell is correctly inserted in the battery holder.
Make sure the battery pack is connected with the correct polarity.
The unit will withstand polarity reversals of short duration but don't leave the battery reversed for minutes rather than seconds.
The author has constructed 6 units and all worked first up so it's not too hard.
The good news is that it's pretty difficult to permanently damage any of the parts... but... stand by for the emails from those who "succeed".
If you have a voltmeter or DVM select the 200 volt range and connect it across the output. Fit the batteries and briefly touch the battery connector to the battery pack terminals. Voltage should immediately appear.
If not inspect and inspect again.

WARNING: If you are fitting the unit to a battery powered portable take great care with the battery plugs particularly if you do not have the original batteries.

Many portables had combined A and B batteries, others had separate plugs. Colour codes on battery plugs can be different to what one would expect.
Using a DVM on ohms range check the battery plug and locate the filaments.
If the filaments are in a series chain remove a valve to confirm you have the right leads.
If in doubt don't connect the unit but trace the wiring instead.
The polarity of the A battery is important.
If no sound is heard, or if only a brief burst is heard, try reversing the two A battery leads.
My hope is that by using this design and future ones we can wake these beautiful little sets from their long sleep and once again freely use them as the portables their designers intended, and at a running cost much lower than ever before possible.

all correspondence will be entered into........
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Editor's Note: This article first appeared in the April 2001 issue of "Radio Waves", the offical publication of The Historical Radio Society of Australia and is reprinted here in it's original form with the author's permission. It came at a time when our club President, Frank Simonsen, and I were both struggling with this problem and offers an entirely new solution. I hope you have enjoyed it as I have.
K. Allison