

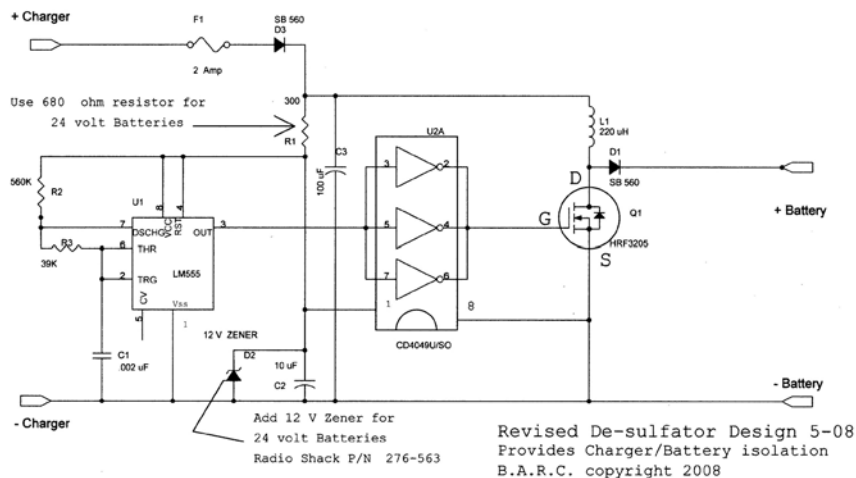
## Pulse De-sulfator for Lead-Acid Battery Resurrection ---Dave Barker

Resurrection of weak or sulfated lead acid batteries—Dave Barker EAA Chapter 79

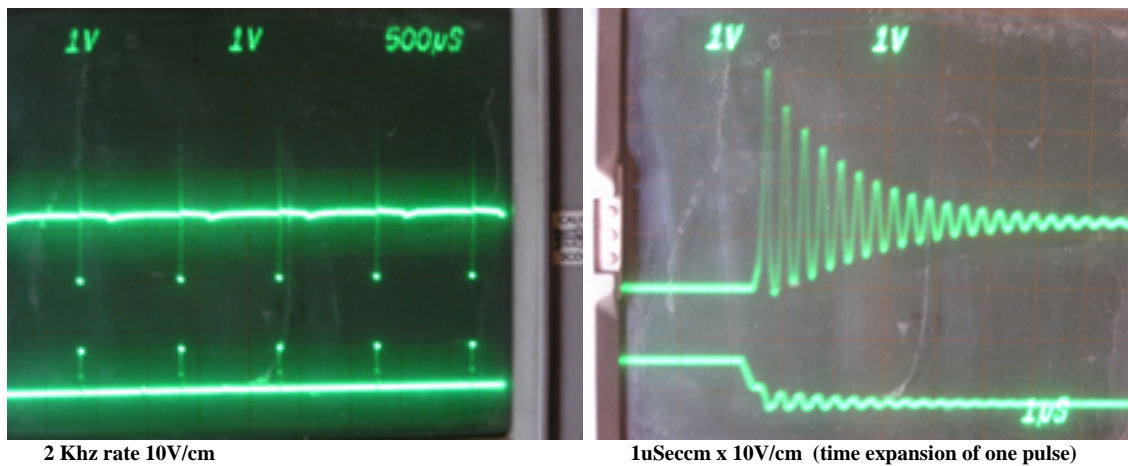
The chemical process responsible for the function of lead acid batteries have several competing chemical processes ongoing in the cell. The most familiar and desirable process is the production of electric current due to ion exchange in the acid electrolyte. Most batteries have a maximum life of about 4 to maybe 5 years whether you use them or not. The primary battery failure mechanisms are over currents that buckle the lead plates leading to a short circuit of the cell. That is not repairable. However, the more common failure is sulfating. This is an alternate chemical process within the cell that rains down snowy white sulfate flakes precipitation that accumulated at the bottom of the cell and gradually reduce its output and current discharge capacity to zilch. The good news is that this can be fixed and you can about double the life of your battery.

### Pulse De-sulfator for lead-acid type battery

This project is a lead acid battery pulse desulfator for restoring and maintaining low use battery applications such as boats and planes. This device will restore a completely sulfated (not a shorted or high resistance connections between cells) battery in about 2 weeks. It will also about double the life of a conventional battery with regular use.



**How it works.** The De-sulfator dumps very short high frequency ringing bursts of current into the battery. These high frequency currents are at a low enough duty cycle to prevent any buckling of the lead plates. It is delivered at 3.6 Megahertz frequency that roughly matches the molecular resonance of the sulfate molecule. This energetic burst has sufficient energy to cause some secondary or deep ionization in the Sulfur atom that will allow the sulfate molecules to move back into the acid electrolyte solution.



Oscilloscope photos above show the typical ringing waveform (time expanded)

### Circuit Operation

The pulser inserts in the 12-volt line between a trickle type battery charger and battery. The energy from C<sub>3</sub> the 100µF capacitor is switched into inductor L<sub>1</sub>. When the Transistor switches off, the inductor field collapses and generates a burst ringing voltage on the order of 50–60 volts and as high as 40 amps or more for about 20microseconds. This burst is repeated 2000 times per second. This very high current is then dumped via the fast recovery diode D1 into the battery. High current pulses produce the secondary resonant ionization of the sulfate precipitate electrolyte. Diode D2 isolates the pulse circuitry from the battery charger. The sulfate is moved off the bottom of the cell and back to work into the electrolyte solution. The 100µF capacitor takes energy from the charger for most of its running time and discharges short high voltage pulses into the battery via the diode. (>> 1% duty cycle). This particular design is suitable for the small amp hour aircraft style and kid scooters etc, gel cell batteries. Larger batteries i.e. golf carts, diesel engine batteries require a higher power de-sulfator. Also, it is recommended that you must then keep the leads between the battery terminals and PC board less than 12" long. This will maximize the energy dump into the battery and help limit RF radiation via the connecting wires.

### Application

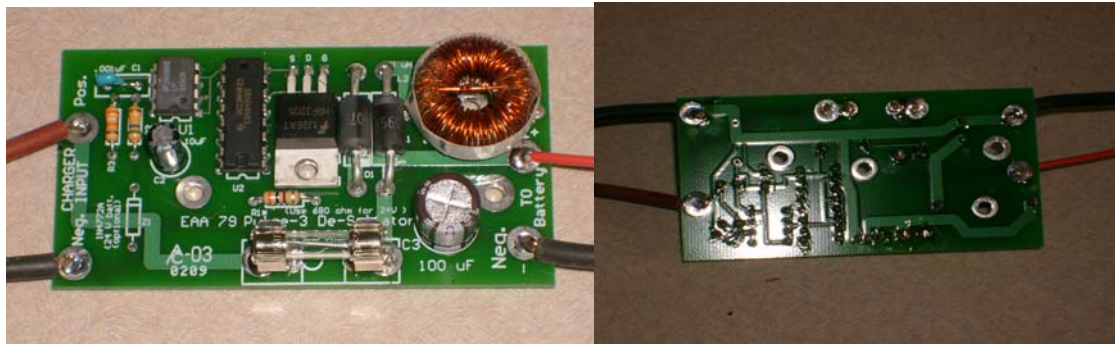
Use a 2-amp fuse with the pulser. Note the charger and battery polarity, **Do not** connect it backwards! Simply attach the pulser input connections to the output leads of a trickle battery charger, and the output connections to your battery. A highly sulfated (non-shortcd) battery may take as long as 2 weeks to recover to nearly new performance. (For the more techie types-- Probing at the battery terminals with a differential oscilloscope during the process will reveal a progressively smaller ring burst amplitude as the battery recovers and its internal cell impedance goes down.) Regular use on your aircraft battery should restore a sulfated battery's to near its rated amp-hour performance life and discharge capability.

If you don't have an oscilloscope handy, you can test for operation by placing an AM radio near the PC board. When it is pulsing you will hear a loud 2 khz tone everywhere on the AM radio band when the unit is operating.

**Please note:** If you use the pulse de-sulfator on a battery installed in your aircraft **do not** turn on the aircraft master switch while the de-sulfator is connected to the battery. It is unlikely, but not impossible that the high voltage pulses may get thru your avionics power input protection circuitry! Be smart, be prudent. **Take care** of your radios!

### Construction

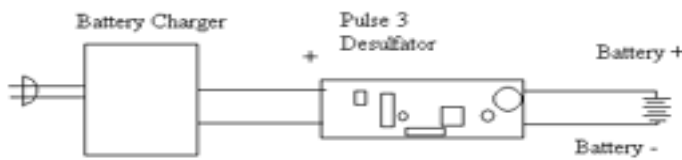
Use 560K (Green, Blue, Yellow) color code resistor for R2. For R3 use 39K (Orange, White, Orange) R1 is 300 ohms (Orange, Black, Brown) Note the polarity marks on the electrolytic capacitors. and orient properly. (C3 & C2 100uF and 10 uF negative lead is near white stripe. C1 is non-polarized.

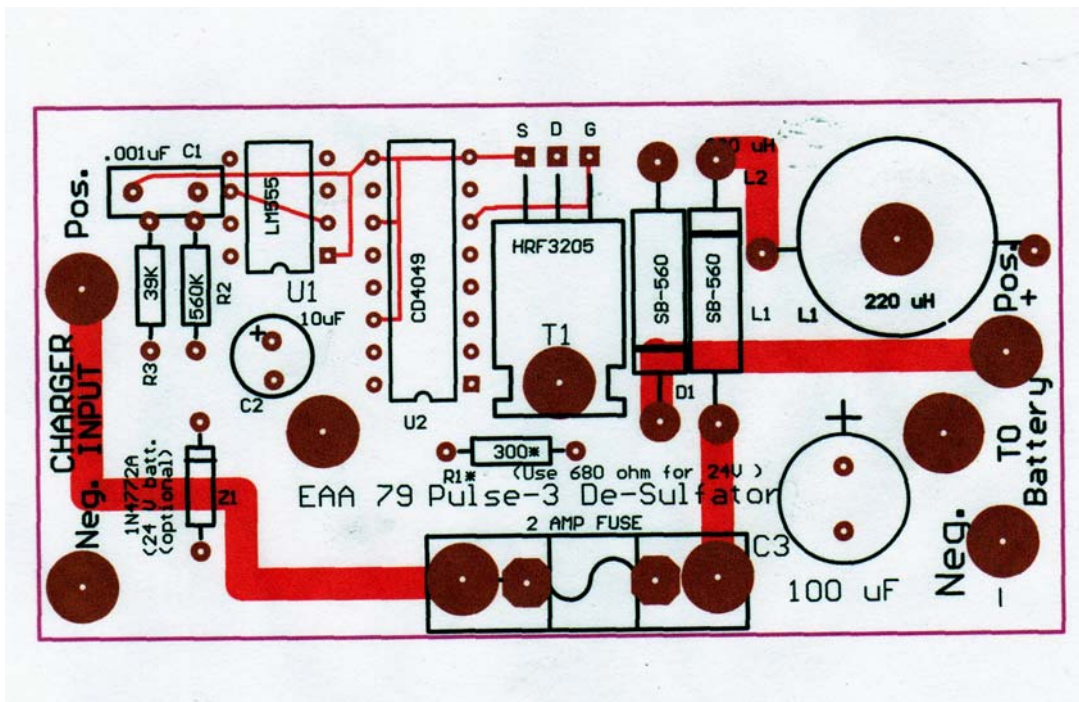


Front (component) Side

Back (solder side)

Install L1. wires into the terminal holes and set the inductors in place as shown.. Install the components in the circuit card as shown and solder use a short pieces of 16 gauge wires to connect the Right (battery side) of the circuit board to the plus and minus leads of the battery. The leads on the left side of the PC board go to the battery charger. The box enclosure of the circuit card is left up to the imagination of the user. You may mount it in the battery charger case or in an external chassis box available at Radio Shack. If any of you have 24 volt battery systems, increase the value of R1 to 620 ohms and add a 12 Volt Zener diode (Radio Shack PN 276-563 (1N4772A) ~ \$0.65 ) in parallel with C3 to limit the voltage on the timer and inverter components.





Parts Layout

PULSE DE-SULFATOR PARTS BOM

Comment	Quantity	Components	DIGIKEY PART#	KEMET/ NICHELSON
.001uF	1	C1	399-2017-ND	C317C102K1R5CA
10 uF	1	C2	493-1057-ND	UPW1E100MDD
100 uF	1	C3	493-1936-ND	UPW1J10MPD
Diode	2	D1,D2	SB560CT-ND	SCHOTTKY DIODE
300*	1	R1*	300QBK-ND	*( use 620 ohms for 24V batt.)
560K	1	R2	560KQBK-ND	
39K	1	R3	39KQBK-ND	
CD4049UBE	1	U2	296-2055-5-ND	
HRF3205	1	T1	HRF3205-ND	Harris Semiconductor
LM555 N	1	U1	LM555CNNS-ND	
220uH Inductor	1	L1,	M9779-ND	
2 amp Fuse	1	F1	507-1278-ND	
Zener (optional)*	1	Z1	Radio Shack PN 276-563 (1N4772A)	
Circuit Board	1	BPDS-3	B.A.R.C.	Page 4