EduTek

Electronics For Students, Teachers & Engineers

BATTERY CONDITIONER

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Living in the UK, we tend to have precious few hot sunny days and if you own a jetski, it tends to be sat on the drive a lot. Unfotunately, lead-acid batteries do not keep well if not used and I have had to buy yet another battery for it.

This project was built to keep a battery "fresh" and fully charged by regularly loading it and charging it back up again - as if it was being used as normal. Good for motorbike and car batteries.

I have used this for monthss and it has kept the jetski battery tip-top!

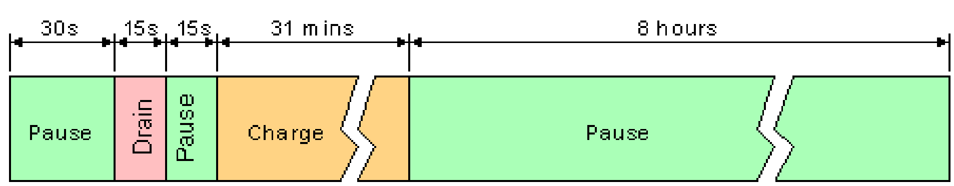
OPERATION

The trouble with lead acid batteries is that if left, they loose charge and after a while go past the point of no return where they simply cannot be recharged again. I use a car and a motorbike most days and the batteries on them have been there for years without any trouble whatsoever. So it seems to me that if you regularly exercise your battery and keep it topped up with energy, it will last you many years. I guess the same can be said of most things - including us.

So that is exactly what this project does. It drains the battery with a heavy load, to simulate starting an engine, then charges it up over a longer period, just like a battery would be charged while driving. Basically using the battery in a similar fashion as if it was connected to a car, bike or jetski.

DISCHARGE / CHARGE / WAIT CYCLE

The operation cycle is shown below. This is repeated every 8 and a half hours.



To ensure the battery level is kept topped up, the charge needs to be 1.5 x current drained.

We will use Amp/Mins rather then Amp/Hours as a measurement - its easier numbers

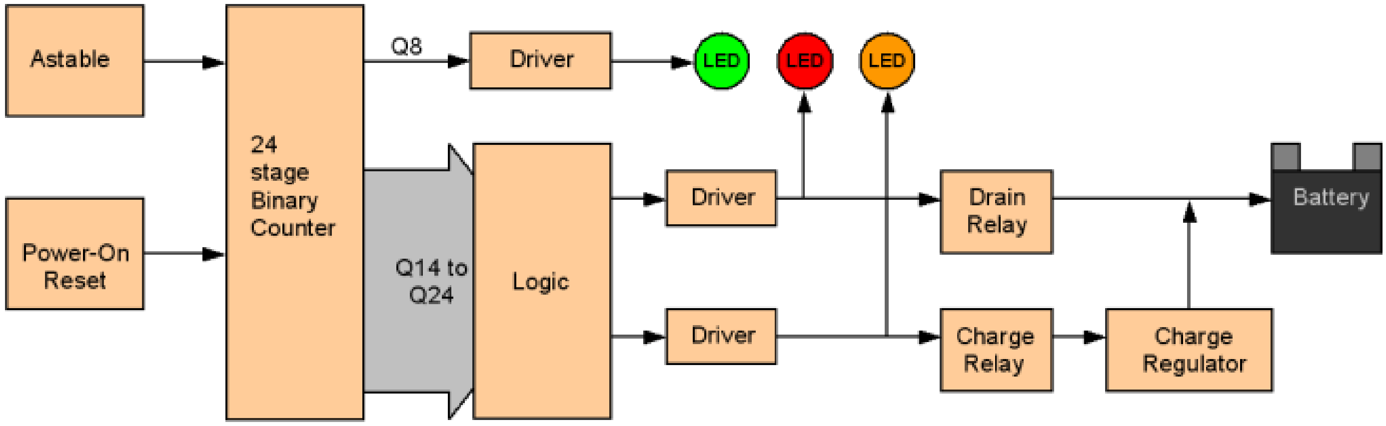
Drain energy = 21A for 15 s = **5.25Amp/mins**.

Charge energy = 0.25A for 31m = **7.75Amp/mins**

So the charge current for 31mins is 250mA to replace the current drained for 15secs.

CIRCUIT DESCRIPTION

CIRCUIT BLOCK DIAGRAM



HOW IT WORKS...

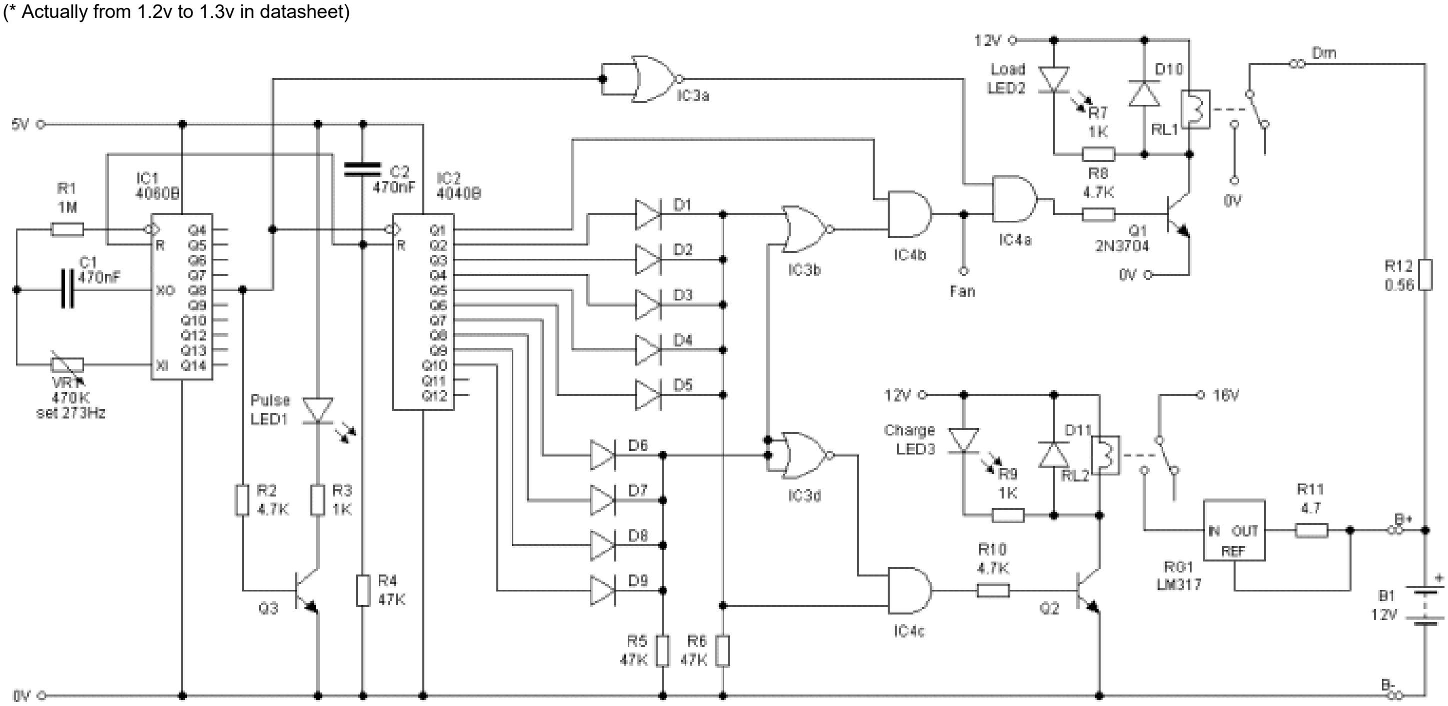
The circuit is based around an astable driving a 24-stage binary counter formed from IC1 and IC2. This is used to develop the long delays needed for charging and the pause before the next cycle of Drain/Charge.
For more details on timing and decoding, refer to the explanation below.

The "Drain" relay RL1, connects the battery to a high wattage, low value resistor while the "Charge" relay, RL2, drives the LM317 regulator wired as a constant current generator to charge the battery. This is set to 250mA using the equation given in the datasheet.

I = VRef / R
I = *1.25v / 4.7ohm = 265mA (close enough).

IC3 and IC4 are LOGIC gates used to generate the signals for the "Drain" and "Charge" drivers formed by Q1 and Q2. D10 and D11 limit the EMF generated by the relay coils and the outputs also drive the LEDs to show the function of the ciircuit.

(* Actually from 1.2v to 1.3v in datasheet)



HOW THE TIMINGS ARE GENERATED...

Taking IC1 first, this has a built in astable at pins 9,10 and 11. This is set to 273 Hz and fed to its counter section. This counter provides 2 outputs:

- At Q8 which divides the astable frequency by 128 giving a frequency of 273Hz / 128 = 2.14Hz (or one pulse every 0.469s). This drives the green LED to show the unit is counting.
- At Q14 which divides the astable by 8192 (2^13) giving a pulse every 30 seconds. This output is fed to the input of the second binary counter thus cascading them into one. Q1 of IC2 is actually Q15 of the overall counter, Q2 = Q16 etc. It is also used by the logic gates to switch the outputs.

IC2 forms the second part of the counter and counts on the low going edge of Q14 and so advances every 30 seconds.
The outputs are decoded using diodes and logic gates to produce the required outputs for the "Drain" and "Charge" relays.
The table below show the decoding.

					IC2					IC1		
Q10	**Q9**	**Q8**	**Q7**	**Q6**	**Q5**	**Q4**	**Q3**	**Q2**	**Q1**	**Q14**	**Action**	**Duration**
0	0	0	0	0	0	0	0	0	0	x	Pause	30 secs
0	0	0	0	0	0	0	0	0	1	0	Drain	15 secs
0	0	0	0	0	0	0	0	0	1	1	Pause	15 secs
0	0	0	0			Any 1			x	x	Charge	31 mins
	Any 1			x	x	x	x	x	x	x	Pause	8 hours

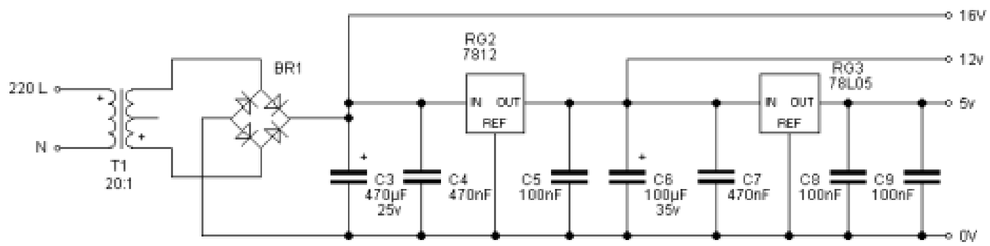
The timings work out so that the cycle repeats every 8 hours and 32 minutes. This can be extended by adding a diode from Q11 of IC2 to the cathodes of D6-9 giving a cycle time of +512mins = 17 hours.

With hindsight this is probably a better cycle time over long durations. The astable frequency is not critical as the time ratios of Drain/Charge never change. So anywhere from 200-300Hz would be ok.

POWER SUPPLY SECTION

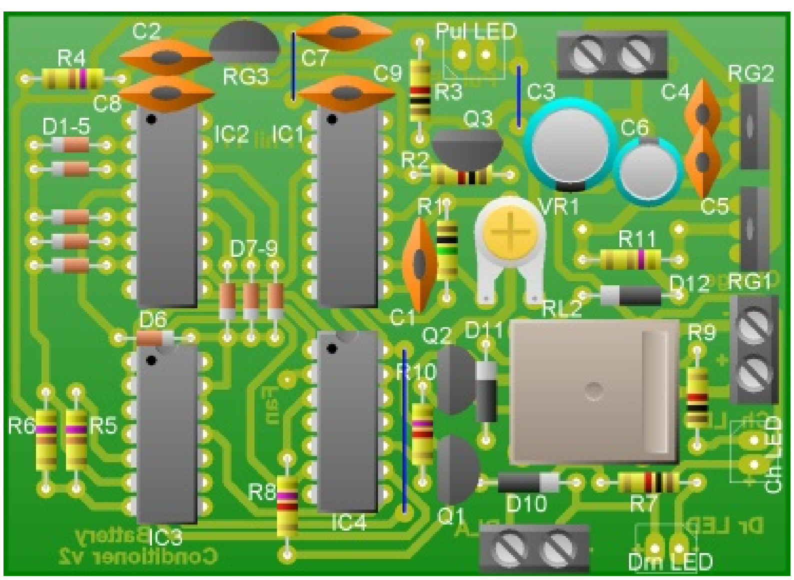
The power supply is driven by a mains transformer and standard bridge rectifier. C3 smooths the supply for the regulators, RG2 giving 12v @ 1A, and RG3 giving 5v @ 100mA. C4,5,7 and 9 provide stability for the regulators.

ALWAYS TAKE CARE WHEN USING MAINS ELECTRICITY - IT CAN KILL!



PCB AND CIRCUIT CONSTRUCTION

CIRCUIT BOARD

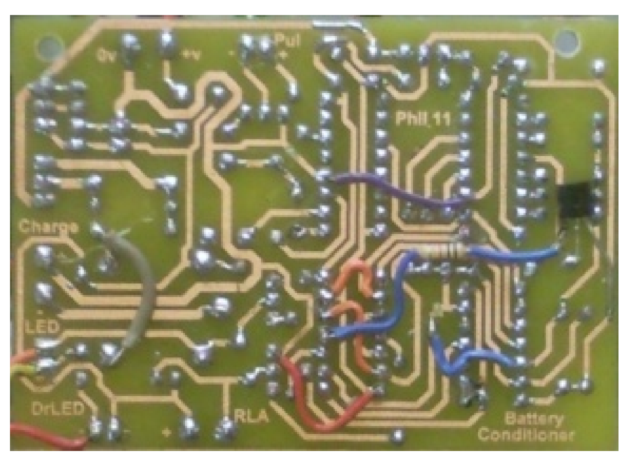


The PCB measures 3.25" x 2.35" (83mm x 60mm)

Note that there are 2 places for R6 which is the current regulating resistor for the charging regulator, you need only use one.

This is the second version as the first one had a few mistakes on which I have corrected.

I also added an extra transistor driver to drive a small brushless fan to help cool the resistor array, but in practise it's not really needed. This output for this is shown on the circuit diagram as "fan".



DISCHARGE RESISTOR

The resistor R12 is the drain load and a quick bit of maths shows it gives off a lot of heat:

I = V/R
I = 12 / 0.56 = **21.4 Amps**

P = I V
P = 21.4 x 12 = **256.8W!!!!!**

Now it's not easy to find such a device so I used 12 6.8ohm 8W resistors. Admittedly this is still not beefy enough but since they only drain for 15 seconds, you can just get away with it. You could increase the value by 2 to ease heat generation but remember to halve the charge current on RG1 by replacing the 4.7 ohm with a 10 ohm reducing the cureent to 125mA.

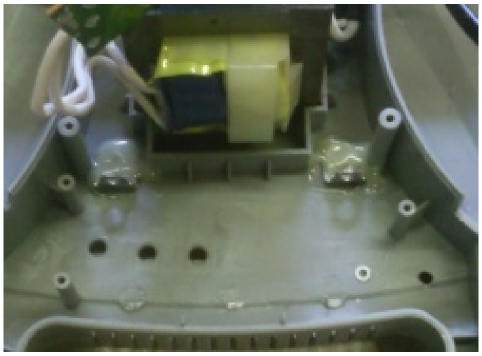
Right is the resistor formed by 12 others. They are all connected in parallel with each resistor drawing 1.76 Amps. They are crimped and soldered onto some very 2.5A mains "twin+earth" cable. Being solid core the wires can be shaped to hold the resistors away from the case.

CASE

The case was an old battery charger I bought and lasted about 2 months then packed up. Luckily the transformer, rectifier and fuse were all ok so I gutted the rest of it and had a ready made case. It even had 3 LED holes on the front!

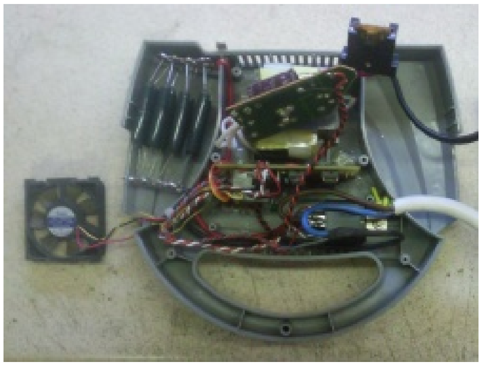
The original PCB was trimeed to remove all but the 4 diodes forming the bridge rectifier BR1, the fuse and the smoothing capacitor.

It has 3 compartments - 2 for the wires and one for the circuitry. This worked out to be perfect for what I needed..



The PCB was held in place by forming some brackets made from meccano - brilliant stuff and so handy! They were files and glued into place using Araldite Rapid.

Here you can see RL1 which is an automotive type as their contacts can take 30A. It is mounted with a bolt through the case . The resistor fitted in a compartment meant fort the charge cables.



All the parts in place with a view of the fan ready to be fitted to the case to provide air flow passed the resistor. Heavy duty mains cable was used for the wires to the battery and the original crocodile clips attached to the ends

DOWNLOADS

- PCB LAYOUT.pdf - check size but it should be correct
- CIRCUIT DIAGRAM using Livewire (simulation has an error on IC2)

Please note that this project can produce high currents and uses Mains voltage. you must seek the help of an experienced adult if building and using this project.

Designed and Written by Phil Townshend - August 2011

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