AN01: Battery charger with charging current limiting and over charge, over discharge protection

The charger is basically designed for charging a Sealed Lead-Acid battery directly from a dc voltage source, in this case solar panel rated 18V/8W in full sun. The basic charger circuit diagram is as follows:

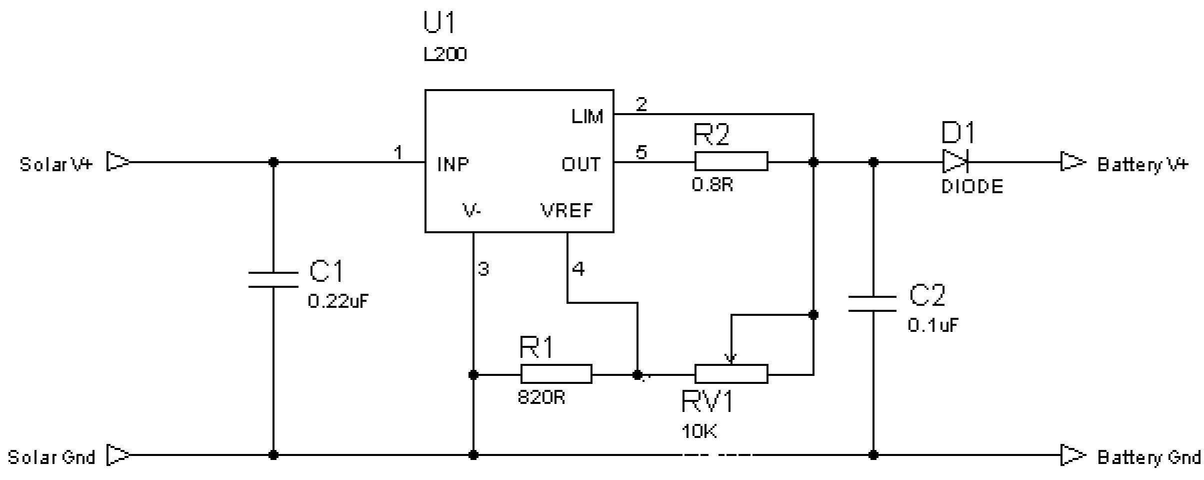

Figure 1: Battery charger

Circuit Operation:

In this Circuit voltage will be fed from the solar panel at one end (18V) and battery will be connected to the other end.

L200 is adjustable voltage and current regulator IC. Capacitor C1 is filtering capacitor to block any ac components of voltage.

Changing the value of R2 will change the maximum regulated charging current (560mA in this case). Formula for calculating this is:

$$I_{out}(max) = (V_5 – V_2) / R2$$

The value of $(V_5 – V_2)$ is constant (responsibility of IC to maintain it constant) and is equal to 0.45V.

Varying RV1 will change the regulated output voltage. If you need to charge the 12V lead-Acid battery the voltage must be greater than 12V (14V will be good).

$$V_{out} = V_{ref} (1 + RV1/R1)$$

Diode D1 makes sure that if somehow charger's output voltage gets lower than the battery's terminal voltage, reverse current does not flow.

Charging Modes:

When fully discharged, battery will draw maximum current. At that time battery needs to be charged in burst mode (at maximum allowed charging current recommended by manufacturer). The manufacturer's recommended burst mode current usually for lead-acid batteries is 0.1Ahr that is 0.1*Battery's Amp-Hour rating (see label on your battery). For Example for a battery rated 5.6Ahr, maximum allowed current must be 560mA.

As the battery gets charged up the voltage difference will decrease and hence the current. So, with smaller current, the charging mode will change to trickle charging mode. The circuit can be left connected with battery forever and it will not damage the battery.

Over Discharge Protection:

Now for over discharge protection, the circuit diagram (taken from internet) is as follows:

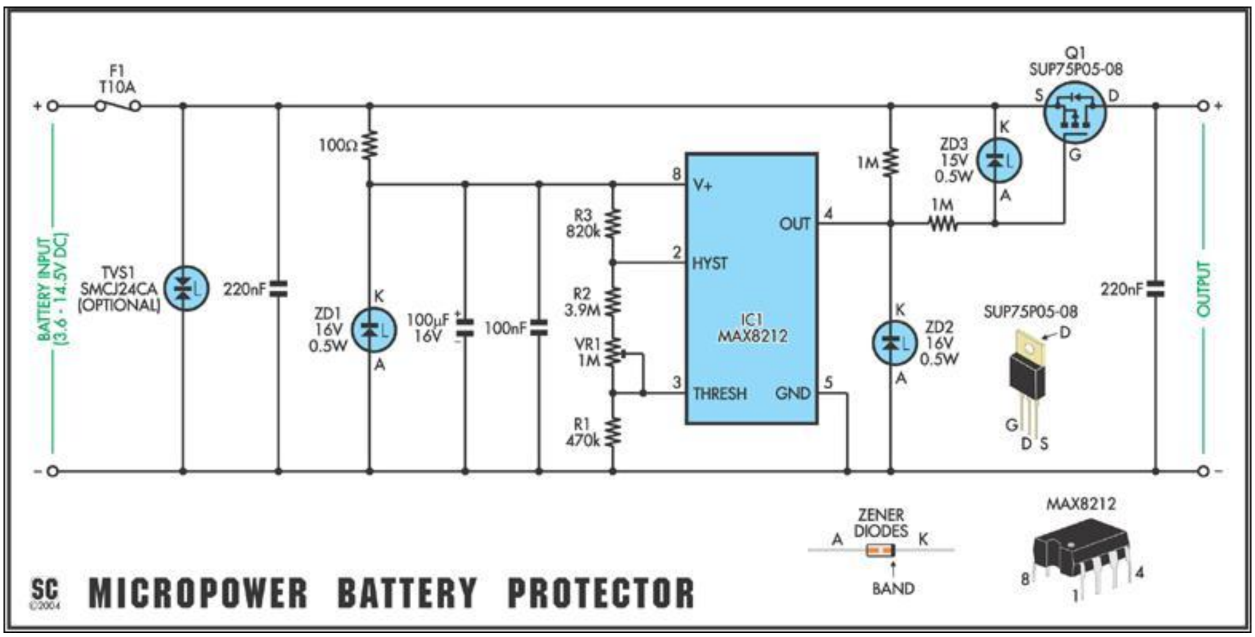

Figure 2: Battery over discharge protector

In the above circuit Battery is connected at the input and load at the output terminals. TVS1 is a 20V VDR which will suppress any voltages above 20V (unforeseen protection). Max8212 is a voltage monitor IC with programmable voltage detection. Varying VR1 will vary the load cutoff voltage. For 12V lead-acid battery a reasonable value is 11.5V, going below this will risk the battery's sever over discharge.

R3 Provides the Hysteresis voltage (voltage at which IC will reconnect the load with battery terminals - cutoff voltage). The purpose of hysteresis is to ensure stability of circuit. For Example if the voltage across the battery falls to 11.5V the IC will turn off the MOSFET Q1 and disconnect the load from battery, now battery will be reconnected to load at (11.5+1) 12.5V if the hysteresis voltage is 1V.

Choosing a value of 820K for R3 will provide a hysteresis of 2V.

Formulas for calculating this is:

$$V_{thresh} = 1.15V \text{ always (responsibility of IC to maintain it)}$$

So, current through R1 will be:

$$I_{R1} = V_{thresh} / R1 = 1.15 / 470K = 2.45uA$$

Now value of R3 can be calculated as :

$$R3 = V_{Hyst} / I_{R1} = 2 / 2.45uA = 820K \text{ (approx)}$$

Where, V_{Hyst} is voltage drop across R3. Current is almost constant in this resistors branch because the current into the IC pins is negligible.

Q1 is a MOSFET SUP75P05 (you can also use IRF4905 instead whichever is available plus the current requirement of load).

Author:
Salman Liaquat
Design Engineer,
TechOne Progressive Solutions Pvt Lmtd,
salman.liaquat@t1pk.com