Switched Mode Power Supply Modification for portable radio operation. By YO3HJV, Adrian

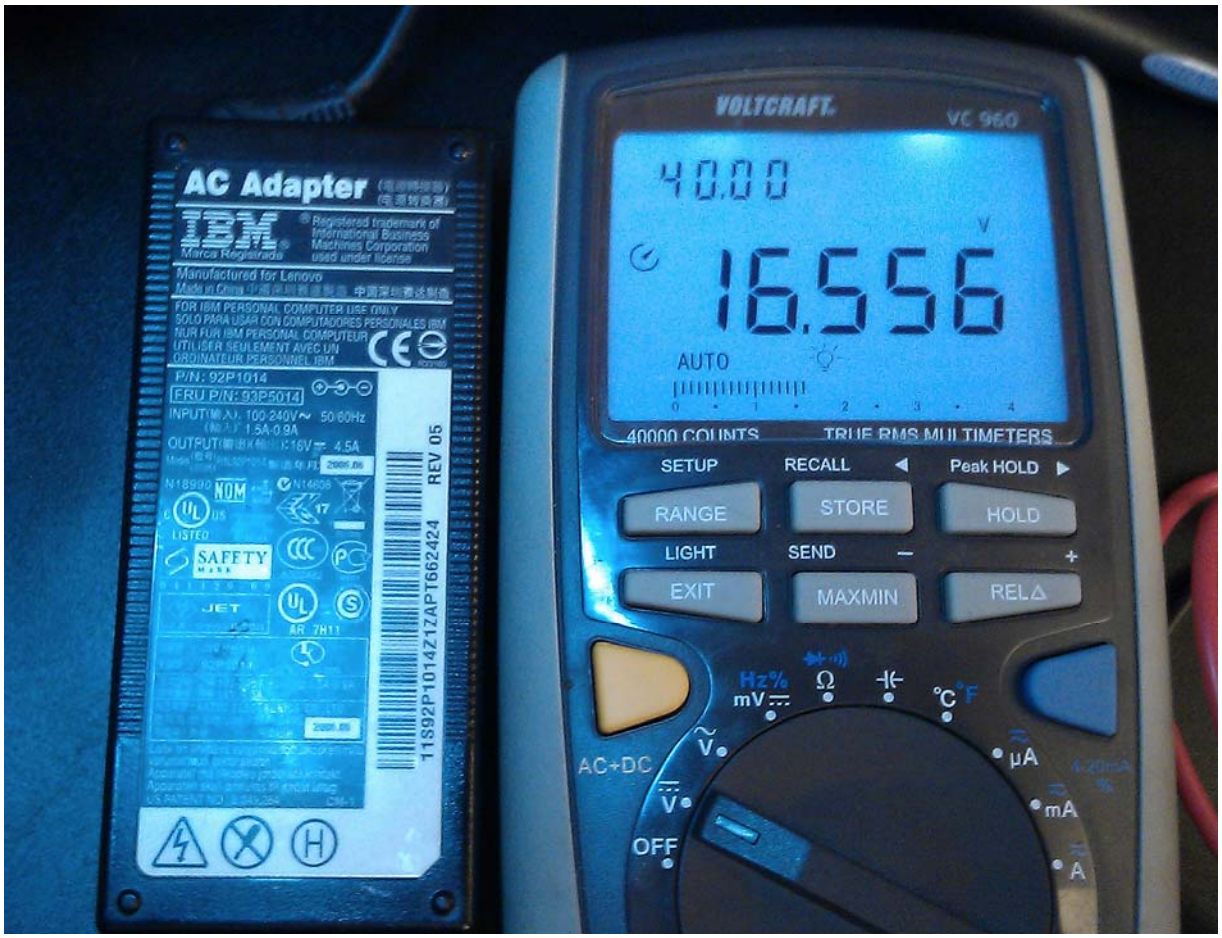
For more than 1 year I was in search for the “perfect” power supply for my travel pack.

In this pack I usualy have a portable HF radio (ICOM IC-703), a portable VHF/UHF radio, a mobile phone and a 2.2 Ah SLA plus some extra stuff requiring 12 V supply.

The ideal power supply is one which is capable of delivering around 3A, have over voltage protection and also shortcircuit protection and not exceed a comfortable volume to fit inside a pocket of my ICOM LC-156 backpack.

The “usual suspects” are the laptop SMPS (Switched Mode Power Supply)! But a very few laptops use exactly 13.8 – 14.4 V which is the best voltage range for using the radio AND charging a little SLA (12 V / 3A) for portable operations (IOTA, SOTA, WFF) where each gram count and it is preferable to keep it compact.

I was looking around in my used equipment boxes and found a IBM 16 V/4.5 A SMPS that fits the profile.



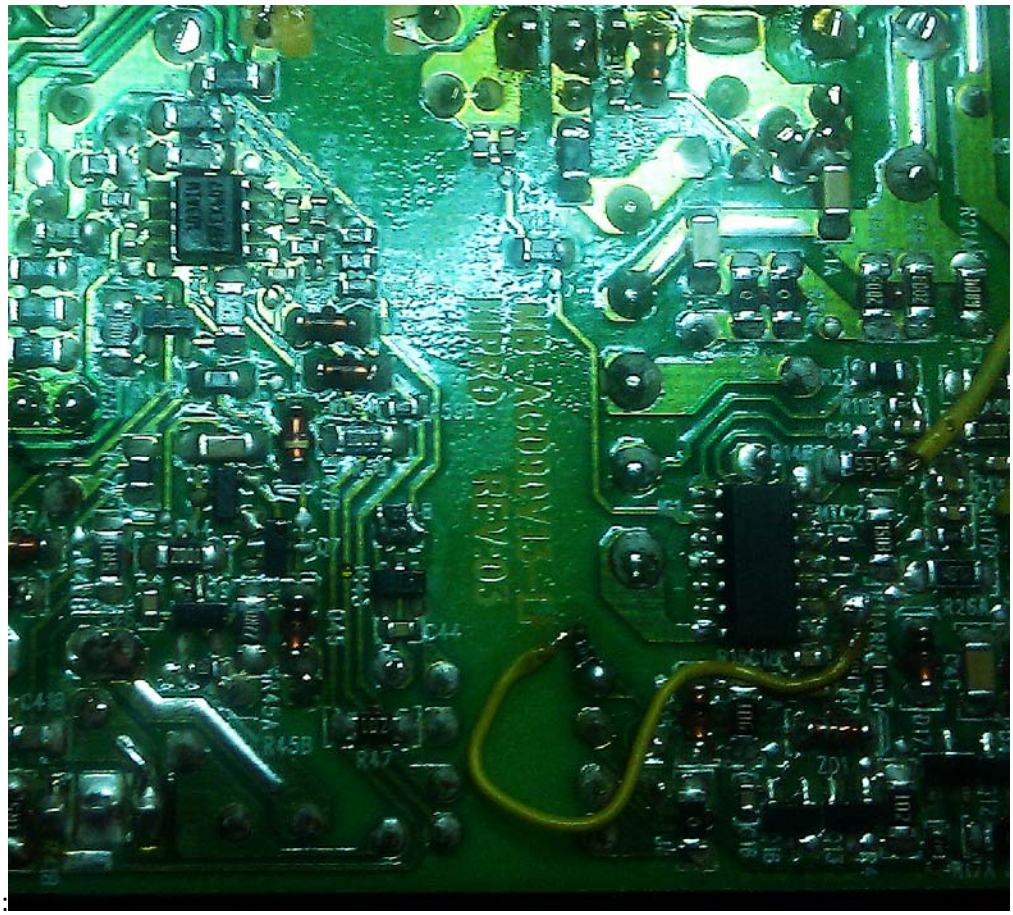
One solution was to use a external linear regulator but a little calculation show that I have to use a rather complex regulator capable of around 10 W dissipation.

Another solution was to use a DC-DC buck convertor.

And a third solution, and the winner, was to look inside and try to modify the SMPS . Of course, this was the winning solution so I proceed.

Carefully use a cutter blade (or Dremel tool).

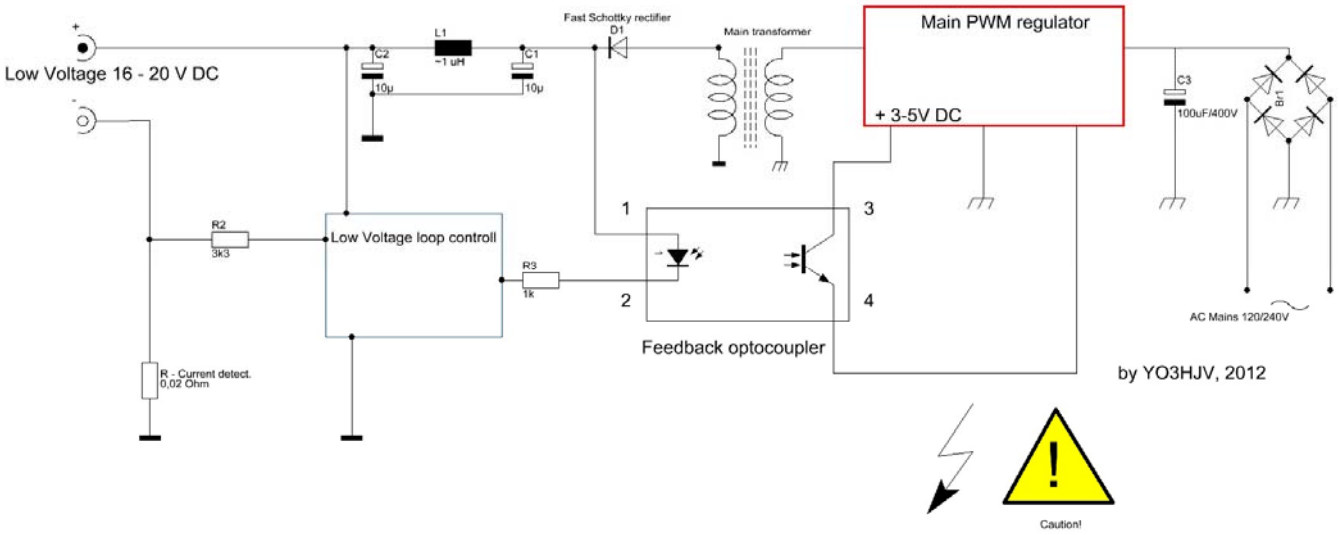
After removing the case and the metal shield, we have access to the PCB board. Looks simething like this one:



You can notice the separation between the two circuits. (*In this picture, the SMPS is not the one I modified because I have the ideea to write this AFTER I pack the SMPS and I glued it! This SMPS has two optocouplers, one for voltage and one for overcurrent protection but the general principle is the same)*

The SMPS is, in fact, composed by two big sections: One is the high voltage one, with the PWM controller (chopper) for the step down and the second section is centered around the feedback circuits (and various protections).

I do not intend to enter in the theory of the SMPS, you can study about them on Wikipedia (http://en.wikipedia.org/wiki/Switched-mode_power_supply).



Here is a basic diagram of what we have in a SMPS:

It is very complicated at a first glance, but if you are familiar with the principles of electronics, you will quickly find that the main component envolved in the regulation and the protection is the Feedback optocoupler.

This is the “link” between the low voltage section and the “brain” of the SMPS, “The Chopper”!

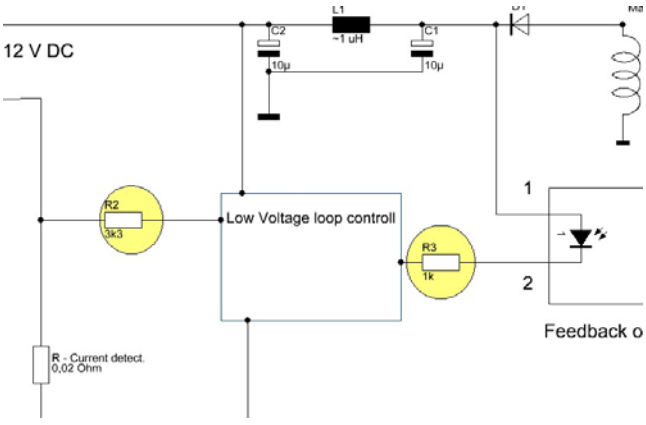
How it’s working?

Basicly, the more voltage you have on the output port, the more voltage is applied to the LED inside the optocoupler and the transistor EC side has less resistance.

There is a very complex equation which express the relation between the variation of the output voltage and the variation of the optocoupler EC resistance but this is not our goal!

To be short, we must say that, if we want to reduce the supply voltage, we have to “trick” the PWM regulator that he provide enough voltage when, in reality, the voltage is what we want and not the initial one.

So, we have to:



-raise the voltage applied to the LED on the optocoupler, or

-raise the voltage to the Low voltage loop controll unit (this unit follows the voltage AND the current at the output of the SMPS).

Therefore, we will replace the R2 with a 1k resistor OR R3 with a 500 Ohm resistor. Not both!

A third method is to reduce the resistance between EC of the Optocoupler, just like the LED is under a higher voltage.

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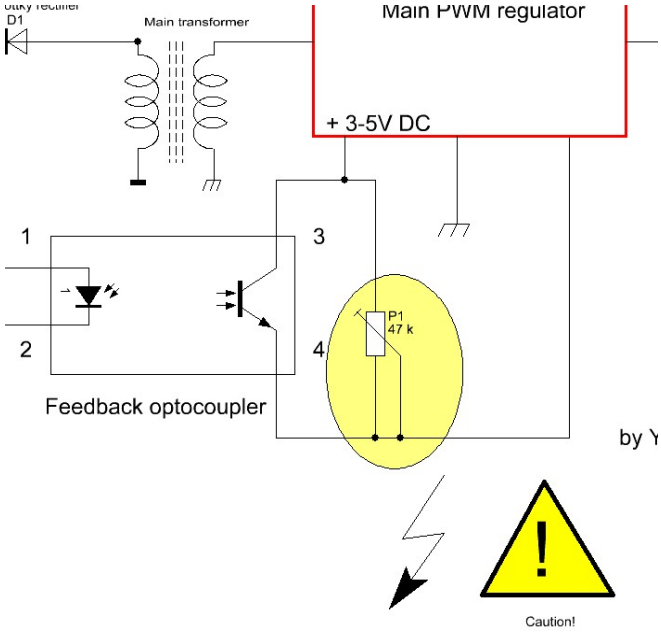
Please, be aware that in this case, you will be modifing the High voltage section, therefore you have to take all the necessary precautions like:

-isolating the tools;

-place the SMPS on a isolated sheet of plastic;

-always, but ALWAYS, unplug the power BEFORE making any intervention, including the fine trimming of the potentiometer.



OK, so, we know how to modify a SMPS with a output voltage higher than the needed one (around 14V).

What about the SMPS with a voltage of 12V?

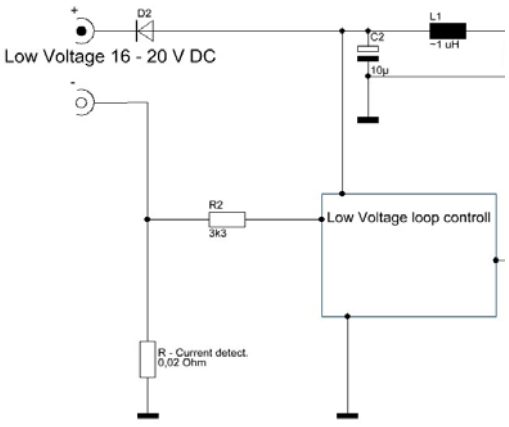
There are a lot of these, generally in the range of 1 – 4 A, which can be usefull if we plan to use it with our radio but the voltage is not enough to recharge a depleted SLA.

Well, based on what we done before, on the same schematic, we have to lower the voltage applied to the optocopuler or to raise the resistance of the EC section of this circuit!

Therefore, we will reduce the voltage applied to the LED or to the Voltage loop, increasing R2 or R3. With a few hundred Ohms.

If you want some adrenaline, you can also put a small resistor in series with the EC circuit on the High voltage side. Respect the same precautions as above!

One more step and we are ready to pack the SMPS back in the case.



The Low voltage loop is very sensitive to reverse currents so **is very wise to add a Schottky diode just before the output of the supply on the + wire!** This prevent also the depletion of a fully charged battery on a disconnected SMPS when in floating charge!

A few words about the SLA and the correct charging:

A floating SLA can be hold in parallel to the SMPS but only if the SMPS's voltage is between 13,4-13,8 V.

A depleted SLA battery need to be recharged at a slightly greater voltage, around 14,4 V but with some limitation to the current. The theory say that the charging current must not exceed C/10, wehere C is the nominal capacity of the SLA *(for a 7 Ah battery, C is 7 A, therefore, the charging current is around 700 mA)*.

A higher current cand be dangerous for the battery but also for the operator because of gas discharging in the SLA cell (highly flammable gas is released).

A depleted battery charging to a lower voltage will not have the rated capacity but around 85% but the charging current can be higher than the C/10.

I am using a 2,2 Ah SLA battery. I fully charge it before going portable and use the charger in floating mode; with the "help" of the D2 (protection diode), the charger will deliver current to the battery only when the voltage of the SLA drops under the 13,7 V which I like to have on the power supply.

At my new 13,7 V compact power supply I put two clamps and a male lighter connector for a "universal" use.

I hope this would be useful for those who want to have a small pack with all what they need for a pleasant "extended" portable operation!

Please consider to do this modification only if you are very lucid and awake! I often made this kind of experiments at night and I smell the smoke a few times because I was very tired and I missed something important!

Also, consider to disconnect the power cord BEFORE making any modification on the PCB. Yes I write this already but I want to be sure you read it!

I am not responsible for any injuries or death of the fellow ham nor to the victim's relatives…

No, I will not give you my IC-703 for your smoked one… Not even you proof that the smoke is caused by a modified SMPS!

I did this mod, I survived but, you know, "Shit happens… sometime"!

73 de YO3HJV, Adrian.

PS
Sorry for my english, is already 23:55 local time…