USE OF STATIC CONVERTERS IN LOGISTICS SYSTEMS

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REZUMAT: This is a continuation of a previous project in which I talked about switch mode power supplies. For educational purposes this semester I will design a PCB and build my one power supply starting from a basic schematic proposed by the company that makes the integrated circuit SP6853. In the next semester I will test the functioning power supply and present datasheets for all the components that I used.

KEY WORDS: SMPS, PCB, SP6853

1. Introduction

A switching-mode power supply (SMPS or switcher) is an electronic power supply that includes a switching controller to convert electricity efficiently. Like other power supplies, an SMPS transfers current from a source, such as the mains, to a load, such as a personal computer, while converting voltage and current characteristics).

2. PCB design

2.1. General PCB design

A printed Circuit Board (PCB) is a staple in the electronics industry and is the physical backbone of electronic schematics and components. They consist of a substrate, usually made of glass cloth and a few microns thick copper foil.

Printed wiring is commercially available in the form of plates of various sizes, with one side plated with copper (single side) or with both sides plated with copper. In the industrial environment, they are used with several layers of copper, for example, the motherboards of the computers have up to 16 layers, but at the amateur level one or two states are enough, this is the reason why I chose to make the wiring on a ceramic plate that has only one layer of copper (top). The multi-layered ones are used for more complex schemes but in my case, it is not applicable. There are some very important steps that need to be followed in order to make good quality printed wiring:

- designing and drawing the wiring in specialized software, I used Eagle;
- printing the drawing on a medium suitable for the purpose;
- cutting a wiring board of the desired size;
- cleaning and degreasing the wiring;
- transfer the drawing on the wiring;
- wiring corrosion;
- cleaning, degreasing, and preparing the wiring;
- making holes for passing parts;
- soldering the parts and testing the wiring.

The design of the printed wiring consists of the allocation of the wiring of a space corresponding to each component of the electronic scheme and their interconnection through conductive paths arranged on one or more levels. Wiring design and drawing can be done with specialized software. Due to its ease and ease, it is possible to use, for example, the software for designing printed diagrams and wiring, Eagle Layout Editor. With this program it is possible to make wiring with a professional look, its possibilities

being innumerable. The Eagle program has three main modules called Control Panel, Schematic, and Board. In Control Panel mode you can find completed projects, component libraries, drawing rules, and more. In Schematic mode, the electrical diagram is drawn and checked for errors and in Board mode, the printed wiring itself is drawn.

As a first step in making a circuit, a principle scheme was chosen, the components were procured and checked on a test board, and then the entire circuit was tested on a test board. It was only when all this was verified that the actual design of the printed wiring was done. After establishing the connection holes of the components from which the design of the wiring design starts, the polarization components will be represented. The design can be done with a view from the components or with a view from the wiring, in which case the components are viewed from the pins (terminals). In order to avoid overturning the drawing in the mirror, the second option is recommended, which, although more complex, eliminates the intermediate stages, giving us the final version of the wiring.

In the second stage, the components from the bookstores were chosen and then placed in the workspace, following their interconnection and the association of a value to each component. The components can be connectors, integrated circuits, transistors, resistors, capacitors, diodes, etc. These components are available in bookstores with many capsule variants, which can be changed as needed when designing the printed wiring. Once the schematic has been made, the design of the printed wiring is based on the principle diagram (the design can be done on several layers). From the program, you can select to view only certain levels, for example, the well-known "top" and "bottom".

Once we have successfully completed the design of the computer and software / Once the design of the computer and software has been completed, we have proceeded to the actual execution of the wiring. I chose a textolite board, which is the best option for my project. Then, I saved the final PCB in the mirror in pdf format, after which I printed it on a photographic sheet, not very thick, the printing being done on a laser printer, so that the ink does not enter the sheet, to remain on the surface. sheets. Then I took the sheet on which the PCB was printed and reduced it to a certain size so that the sheet with the wiring was no bigger than the actual board. After doing this, I fixed the sheet very well on the board, and then by heat transfer with the help of the iron I printed the paths on the photo sheet on the textolite board. It should be noted that the sheet with the printed route must be facing down on the copper side.

The iron must be at a suitable temperature so that the sheet with the route does not burn either, but there must also be enough heat to make the heat transfer as good as possible. Once the tracks have been printed, the sheet will be attached to the plate, both taken and placed in hot water to peel off easily / and to carefully peel them off, the sheet, together with the plate, will be inserted in hot water. Once the routes have been discovered, check again that they have printed well, and if they have not printed well, they are wiped off the plate with acetone, and the last operation is repeated, the one with the iron.

Repeat this operation until the route is printed correctly. There is also the possibility that a single line may be missing after printing the entire route. In this case, that line will be drawn with a permanent marker. After the routes have been done well, the holes are made in the plate, with a not very thick drill, I used a drill with a thickness of about 0.7 mm, the size of the hole must be large enough to have no problems at the time. in which pins must be inserted. After all these operations were done, the iron chloride was taken out and heated very little, which helped faster corrosion of the copper. Leave the chloride path plate for about 10 minutes, it should be placed in a plastic or glass bowl. It can be left longer, depending on the degree of wear of the chloride. After removal, check again if there are broken paths or if there are other faults, because if a path is interrupted then it is no longer justified to continue gluing the components to the board because that board will not do what we need anyway and that is not because of the components. If all is well, then it will be applied with acetone over the remaining routes, in order to remain only the copper, the welds being made much better on the bare copper.

2.2. Component identification

In order to make the static converter, I started looking for different components needed to make it. The first time I looked for the CR6853 integrated circuit datasheet that is responsible for the operation of the static converter. In the datasheet provided by the manufacturer, I found only generic information, which

did not recommend certain components, which led me to define my own technical specifications that must have the static converter, current, and voltage. Given that this project is for demonstration purposes, we decided that the source should have the following technical specifications: 12V, 2A output voltage as current, and most importantly, compact size of the equipment, in the industry this is very important.
Most of the components are commercially available parts, resistors, capacitors, and diodes, the chopper transformer was more difficult to find because it must be of a certain type in order to operate in the parameters.

2.3.Principal scheme

This version is far too simplified, which led me to look for a schematic for a static converter with the same main component IC CR6853, produced by Chip-Rail but from another manufacturer. After searching, I found the SP6853 integrated circuit produced by Sync. Power Corporation, with identical specifications, but a much better scheme of principle and with much better explained technical specifications of the converter.

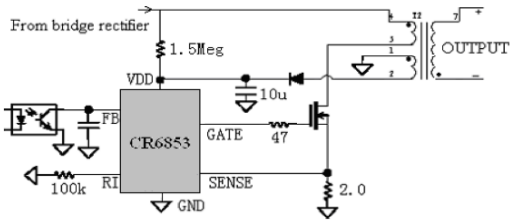

Fig. 1. Scheme proposed by the manufacturer

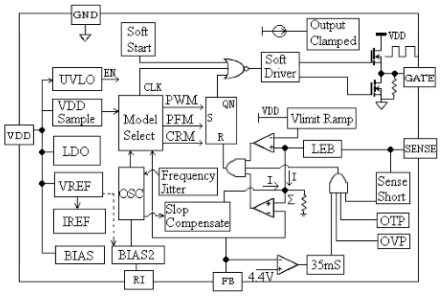

Fig. 2. Internal components of circuit CR6853

The wiring design was done using Eagle software using the schematic scheme proposed by the circuit manufacturer SP6853.

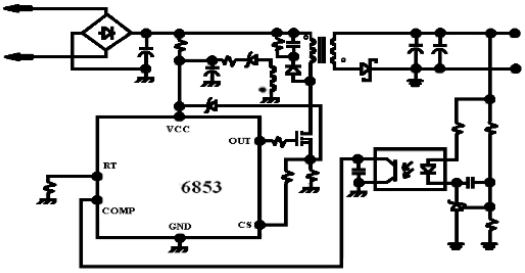

Fig. 3. Schematic diagram with integrated circuit SP6853

In the image below we have an image capture from the design software with some of the components that will later make up the static converter.

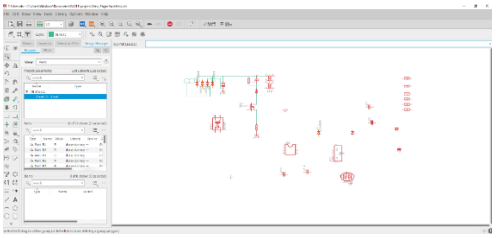

Fig. 4. Static converter electronic diagram

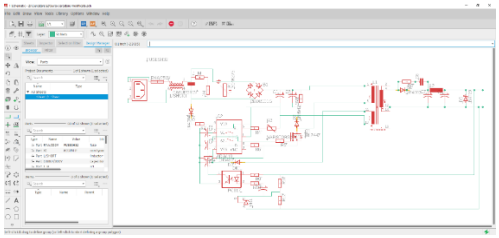

Fig. 5. Electronic scheme

In the image above we find the diagram in the final version of the static converter to be made. The following image shows the wiring to be printed on a photo sheet, the method of making the wiring will be by heat transfer.

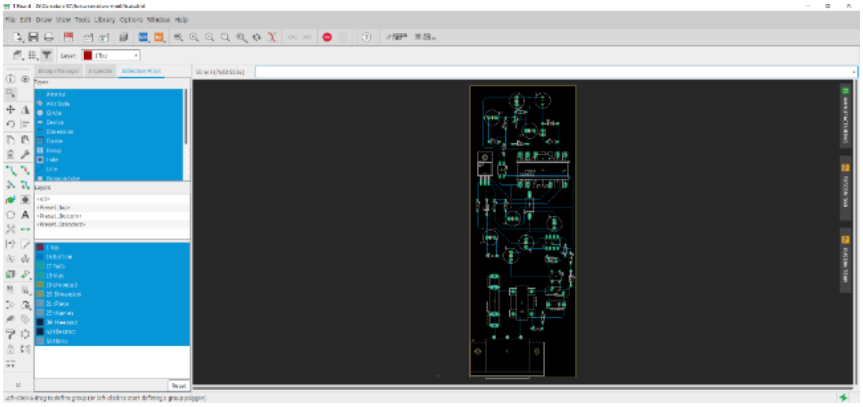

Fig. 6. Static converter wiring

3. Wiring

Below are all the steps we need to take to get the wiring done once it has been printed. Wiring preparation:

Wiring harness (figure 7).

Cleaning the wiring. After cutting, the wiring is first filed on the edges with a very fine file, fig. 8, after which a very fine layer of copper is cleaned with the help of sandpaper, and after that, it is cleaned of impurities and greases with the help of a dishwashing detergent fig. 9.

Fig. 7. Cut PCB to dimensions

Fig. 8. Fieling PCB edges

Fig. 9. Clean PCB

After cleaning, the wiring is carefully handled to avoid contamination.

The toner on the photo paper is transferred to the wiring using the iron. The temperature of the iron should be around 200-230 ° C. We also need to press the iron hard enough to keep the toner from sticking to the wiring properly.

The next step is to put the wiring in a container of water to allow the paper to soften, fig. 10 and then we can detach it from the wiring very easily, leaving only the path printed on it, fig. 11.

Fig. 10. "Ironing" the PCB

Fig. 11. The photo paper before its soften in water

When the paper is soft enough it becomes slightly transparent and we can carefully peel it off. fig 12. In fig. 13 we can see what the wiring looks like after the photo paper has been removed. The next step is chemical reaction pickling with ferric chloride, (Fig. 14).

Fig. 12. The photo paper after its soften in water

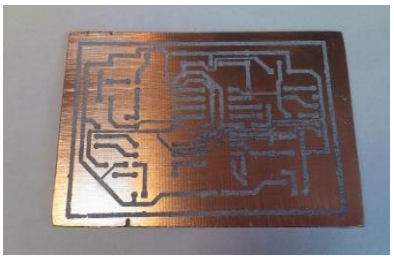

Fig. 13. PCB after the photo paper is removed

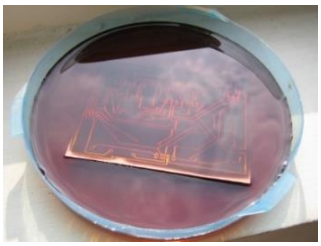

Fig. 14. PCB pickling

4. Planting the components

Once the copper layer is removed from the non-toner protected areas, the wiring is passed through a stream of water to remove traces of ferric chloride. The wiring is wiped with a cloth and then wiped with acetone to remove any toner from it. The wiring is then drilled and then we start planting the components that will later make up the static converter (fig. 15). The order of their planting is from the smallest to the largest dimensions (fig. 16, fig .17). In the picture in figure 18, we have the static converter completed.

Fig. 15. Perforated PCB

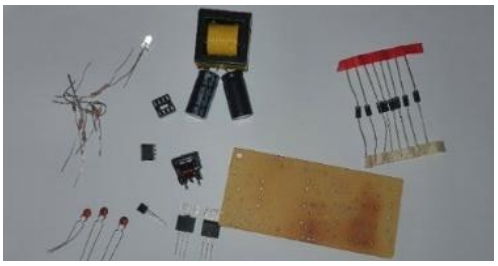

Fig. 16. The components that make up the static converter

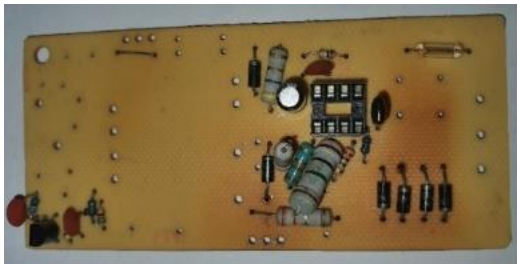

Fig. 17. Placement of components on the wiring

Fig. 18. Static converter

5. Use of static converters in the industry

Today, ensuring uninterrupted supply is a predominant trend in all industries. As is well known, any power outage equates to huge losses in production and distribution, which not everyone can afford. Basic equipment, which now ensures the uninterrupted operation of any business, includes: UPS power supplies, industrial batteries and accumulators, power generators, and small industrial power supplies. The latter will be discussed in more detail below.

Modern industrial automation systems, as well as industrial tools and equipment, are made based on circuits with an increasing level of integration. Control structures are also becoming more complex, and printed circuits are being designed with increasing density. All this increases the sensitivity of the systems to any type of disturbance, including from the supply voltage. Therefore, power supplies with stabilized output voltage and free of defects characteristic of standard sources are most often used for power supply.

A good switching power supply must have the following characteristics:

- High efficiency;
- Wide range of input voltages;
- Dimensions and weight as small as possible;
- Stability of the output voltage, regardless of changes: input voltage, load current, and ambient temperature;
- The lowest possible index of the disturbances generated;
- Appropriate protection elements: overcurrent, short circuit, overvoltage;
- Galvanic separation of input and output.

In conventional power supplies (with transformer), the voltage change and galvanic separation were and are made on a steel core transformer operating at a frequency of 50 Hz, on a semiconductor rectifier, and a linear voltage stabilizer. The efficiency of such a system is very low and does not exceed 50%. This results from the fact that a significant part of the power is transformed into a transformer, rectifier, and stabilizer in heat. The recommended rated output power requires "oversizing" the transformer and a high heat output capacity. These unnecessary losses can be avoided by increasing the operating frequency even to a few hundred kHz and by replacing the voltage regulator with an electronic code with intelligent control.

There are currently many models of switching power supply manufacturers on the market. These include MeanWell, Omron, Siemens, Murr Elektronik, Taiwan's Cabur Enstick and many more.
Several types of static converters are used in the industry, with different output voltages and powers.

Single-output built-in power supplies (single output voltage).
Models with powers of 15W, 25W, 35W, 50W, 70W, 100W, and 150W are now available on the market.

The second type is designed for DIN rail mounting, characterized by narrow housings (the smallest ones are only 22.5mm wide). Included are models with powers: 20W, 40W, 60W, 75W, 120W, and 240W and standard output voltages used in automatic: 5V, 12V, 24V, and 48VDC.
The following range of power supplies is represented by multi-output power supplies:

- With two channels with 30W, 50W, and 120W powers and voltages: 5V, 12V, and 24V in different combinations;
- With three channels with the powers: 30W, 40W, 50W, 60W, and 100W and the voltages: 5V, 12V, 15V, 24V and –5V, -12V and –15V in different combinations;
- With four channels with the powers: 60W and 120W and the voltages: 5V, 12V, 15V, 24V and –5V, -12V and –15V in different combinations.

A novelty is the range of static converters of rain-proof type, in housings and with integrated fans, for forced external cooling. Models with powers: 100W, 150W, 250W and 350W and with voltages: 5V, 7.5V, 12V, 13.5V, 15V, 24V, 27V and 48VDC are available here. Each type of converter mentioned above is protected against overload, overheating, overvoltage, and short circuits. Receiving a stable working voltage at the output is possible after only about 150ms, of course at a full load at the output (or outputs).

6. Conclusions

In the future I will test and see how the power supply can perform in a day-by-day use. All the efficiency and reliability of a SMPS can come at a cost, down below there are some advantages and disadvantages of using a static convertor.

The most important advantages of switching power supplies compared to transformer power supplies are:

• Low weight and low volume at high power.
• Increased yield.
• Low capacity of high-frequency filter capacitors.
• No hearing impairment.
• Resistance to mains disturbances and short voltage drops.
• Short circuit protection integrated into the source circuit.
• Easy operation of different voltage outputs (sources with several outputs with different voltage values).

Major faults in switching power supplies include:

• Generation of broadband disturbances.
• Slow impulse response.
• Complicated input and output filters.
• A large number of subassemblies.

7. Bibliography

[1]. https://en.wikipedia.org/wiki/Printed_circuit_board
[2]. https://www.alldatasheet.com/datasheet-pdf/pdf/1314382/ETC1/CR6853.html.
[3]. https://www.alldatasheet.com/datasheet-pdf/pdf/301818/SYNC-POWER/SP6853.html