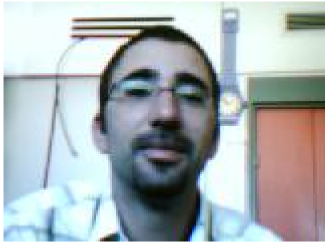
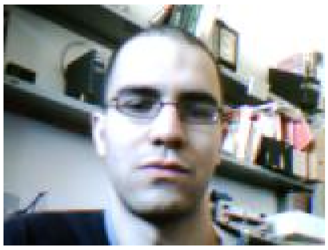
Project: AC-AC Electronic Transformer .

Students		
	Sabag Lior ID:	
	Zisman Eyal ID:	

Supervisor: Prof. Sam Ben-Yaakov

Year: **2005 / 2006**

Abstract

The widespread use of the AC transformer was implemented by the electronic industry many years ago. The electronic AC transformer is a very efficient way of varying AC voltages. When examining the implementations of this apparatus in modern applications (e.g. ignition of DC motors, hydraulic pumps, dimmers, heat control, etc), it is clear that this technological innovation is reaching fruition.

Electronic AC transformers are designed in such a way that they can exert a wide range of powers from several watts to Megawatts.
The use of the electronic AC transformers is particularly popular, due to its low price, small size, rapid reaction and high efficiency, compared to the conventional transformer.

Over the years standards have been established in order to predetermine acceptable levels of infecting harmonies of the load voltage, the inductor current and the entering current. The harmonies of the entrance current return to the supplying net, contaminating its pure sinusoidal harmony, a very undesirable phenomenon.

Previous typologies of the electronically AC transformer have suffered from a range of different problems, beginning with low power factor, high contamination of energetic harmonies, low efficiency, the dead-time problem which causes high voltage heatstroke, etc.

Many efforts have been made over the years to find a method to reduce these problems. One such method is the PWM switching, which enables a better filtering harmony and therefore a better (higher) PF at entrance.

Among these efforts, some new PWM switching typologies have been tested. For example, one was aimed to cope with the fact that for capacitive and inductive loads, the entering voltage and the inductor's current have a phase that they compare each other, with the assistance of a smart switching algorithm. This also solved the dead-time problem. In another typology, the switching angles were calculated beforehand with the use of a "Genetic Algorithm". This method gave a better amelioration to the filtering of energetic harmonies in the switching frequency.

The main objective of this project – we tested a new topology which uses a combination of the serial IGBT switches, which are based on transistors, and parallel SCR switches, with a PWM switching method.

We found out that the SCR switches are able to work efficiently with high frequency switching and we note the limits of capability with working at such high frequencies.

Additional goals include acquiring a good harmonic filtering, an efficient PF, an ability to work with small values of current, and improving the sensation of the entering voltage and inductors current.

Demands

- Working with resistive loads.
- Maximal power of 300W.
- Maximal current of 2A.
- Working with voltage values of 180v-260v.
- Outlet Sinusoidal signal.
- Attenuation of the outlet signal at 10%-100%.
- Maximal outlet ripple of 15%.
- Protecting the circuit from high currents.
- System shutdown when currents above 5A are reached.
- Maximal distortions in input current of 15%.
- Withstanding standard polluting current harmonies.

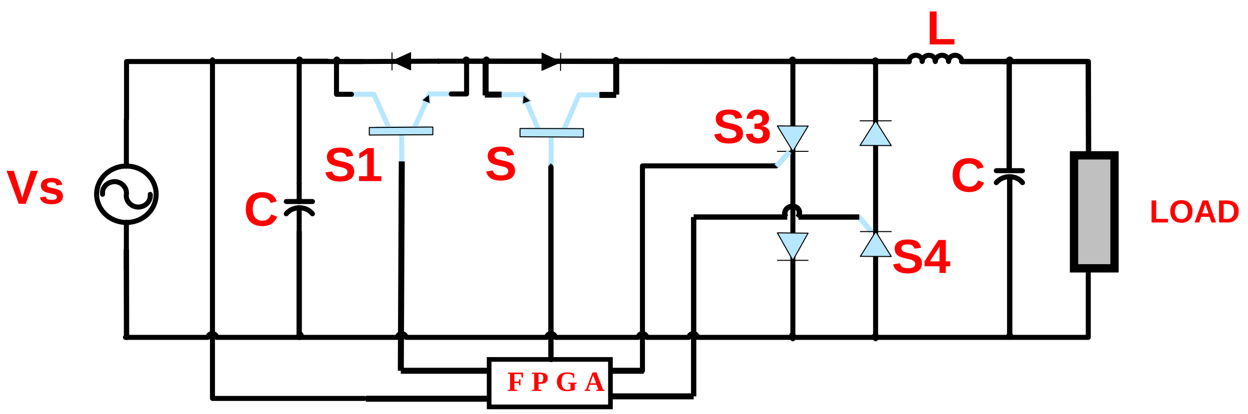
Motivation

- A circuit that uses an SCR switch instead of an IGBT switch is a more robust one. For example the SCR switch can absorb large amounts of load in its gate, while the Mosfet and IGBT cannot, as their gates may crack under pressure. Simply put, the SCR are more durable, particularly under the output that this typology is meant for.
- In addition, the SCR is a simpler switch in terms of physical structure. It contains less parasitic capacities, therefore less undesirable parasitic occurrences, which occur at high frequencies.

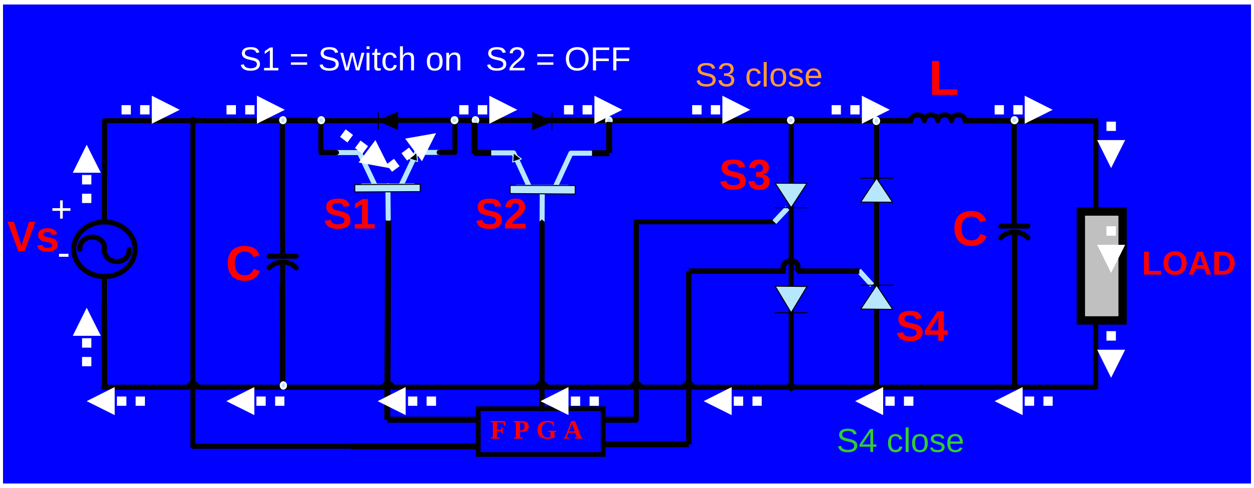
- Another important factor to consider is the price of the switch. The SRC is less expensive than the IGBT.
- Modern systems still use IGBT switches extensively. The advantages to these systems are clear – smaller magnetic components in the circuit, high frequency work, etc. However, despite these advantages make the systems less reliable.
- The SCR requires a very short switch-time, meaning that it is necessary to supply a load quickly, turning the switch on. In the IGBT a constant flow of current is required.
- An outstanding advantage of the SCR is that it is possible to supply a reverse flow through the gate, significantly speeding up the unloading of the switch.

<u>Principle</u>

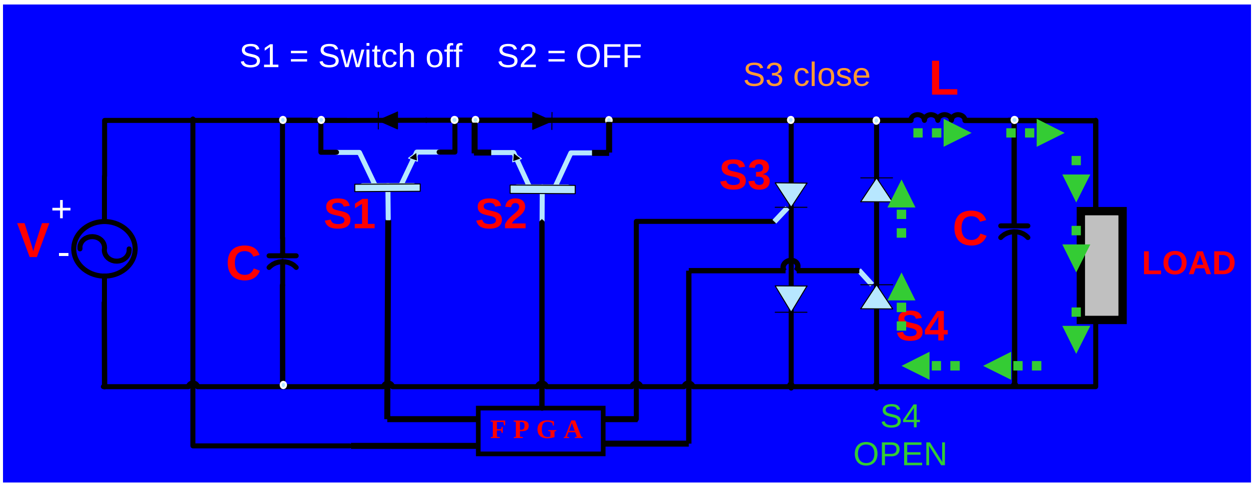
The circuit



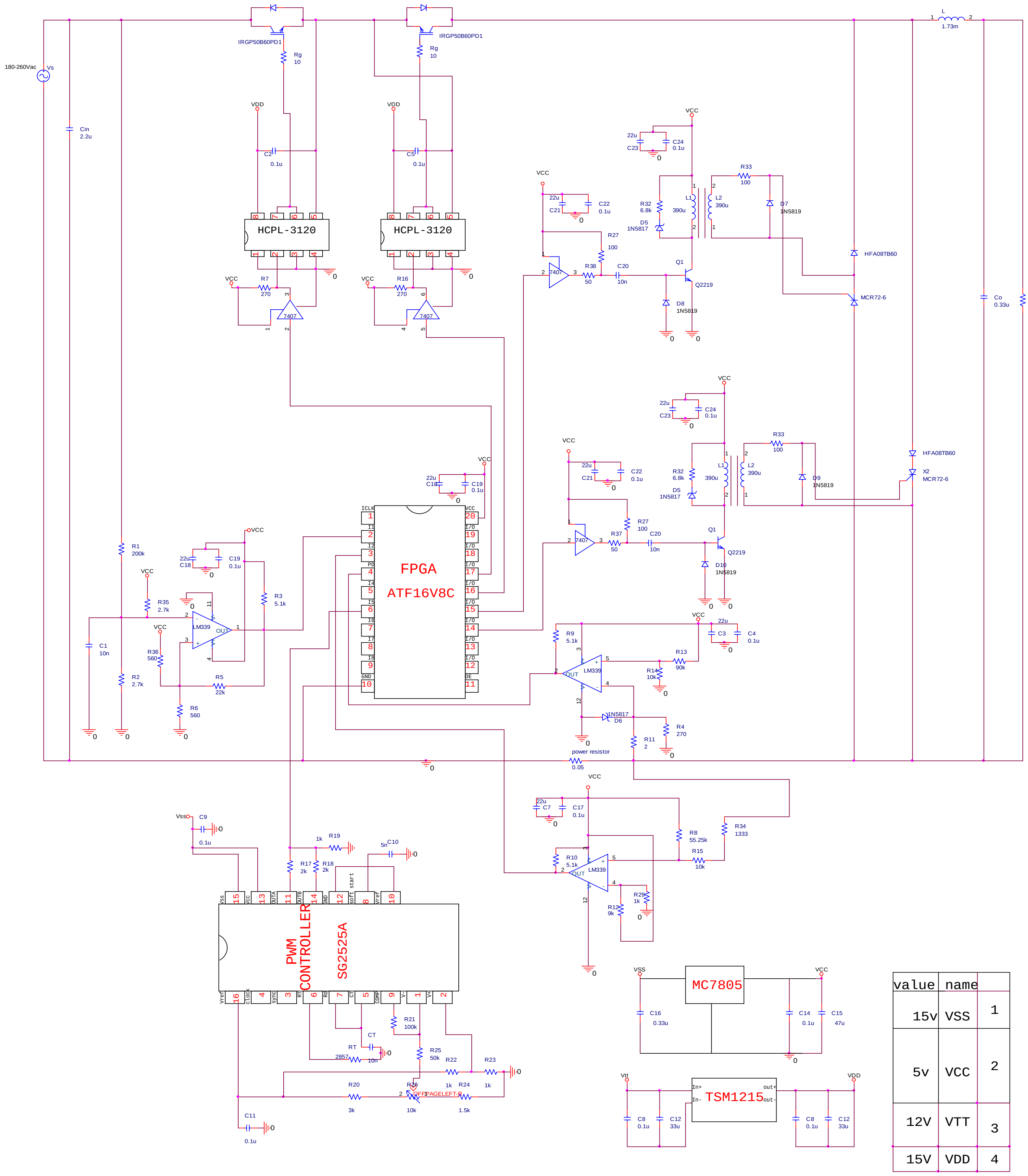
Normal Path   Vs > 0



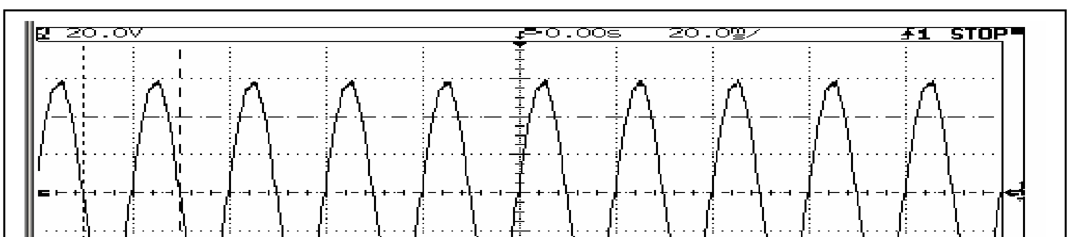
Freewheeling Path



Note : the same process at Vs<0 (switches S2 & S3).
The circuit

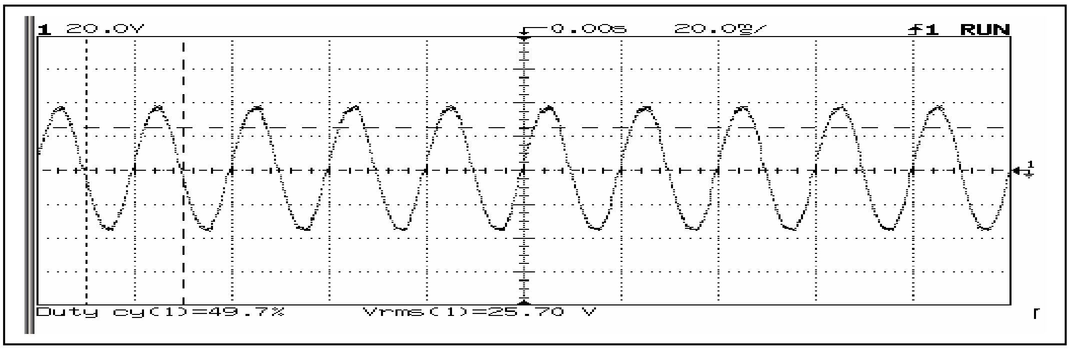


Output Signal

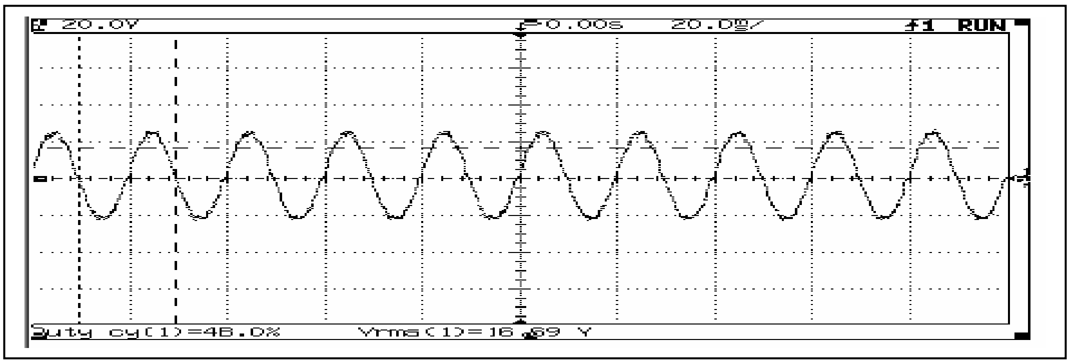


a.

b.

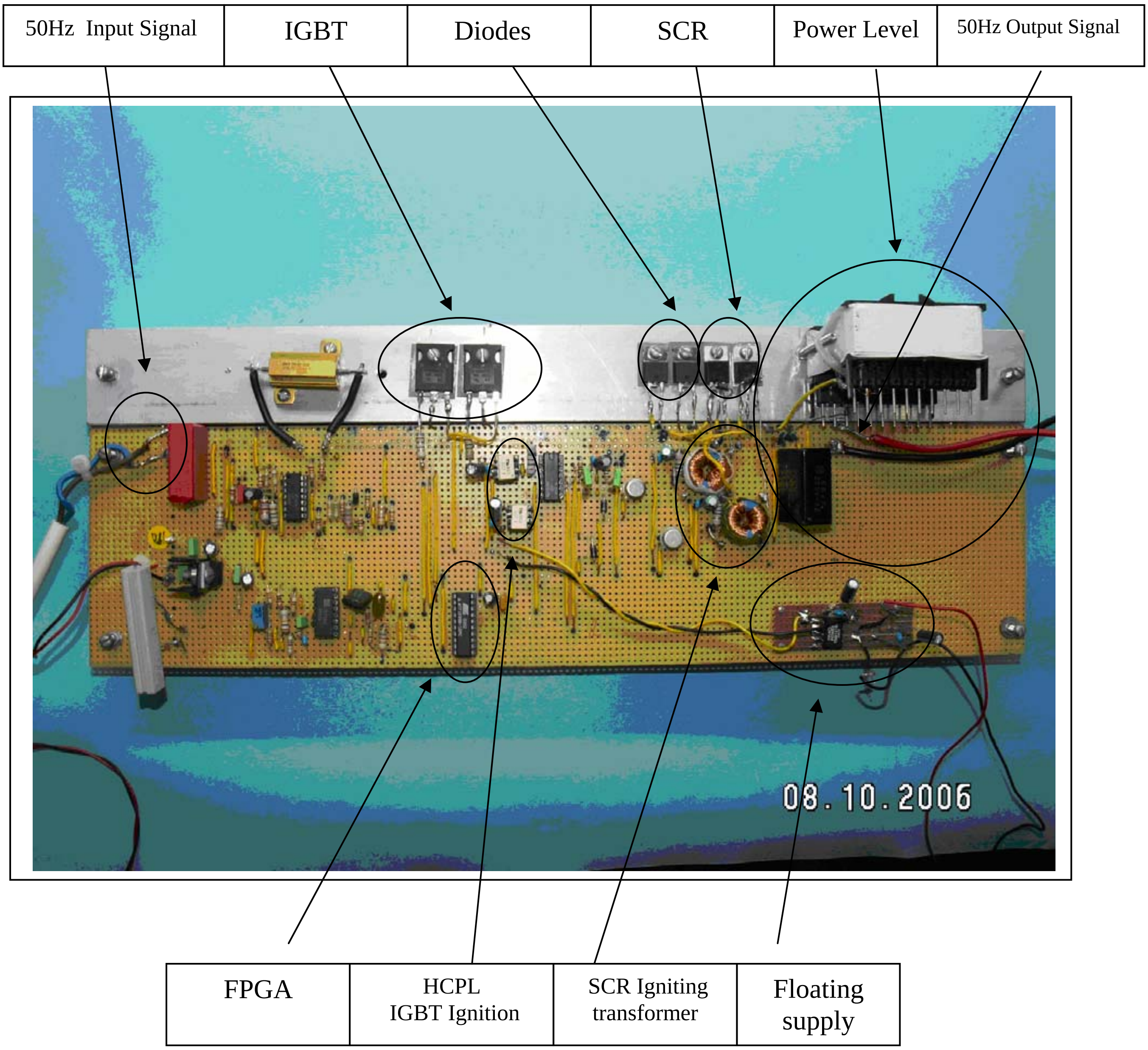


c.



a. Output voltage signal for D=0.7;
b. Output voltage signal for D=0.5;
c. Output voltage signal for D=0.3;

Note: Vin = 85[VAC].


50Hz Input Signal
IGBT
Diodes
SCR
Power Level
50Hz Output Signal
08.10.2006
FPGA
HCPL
IGBT Ignition
SCR Igniting
transformer
Floating
supply