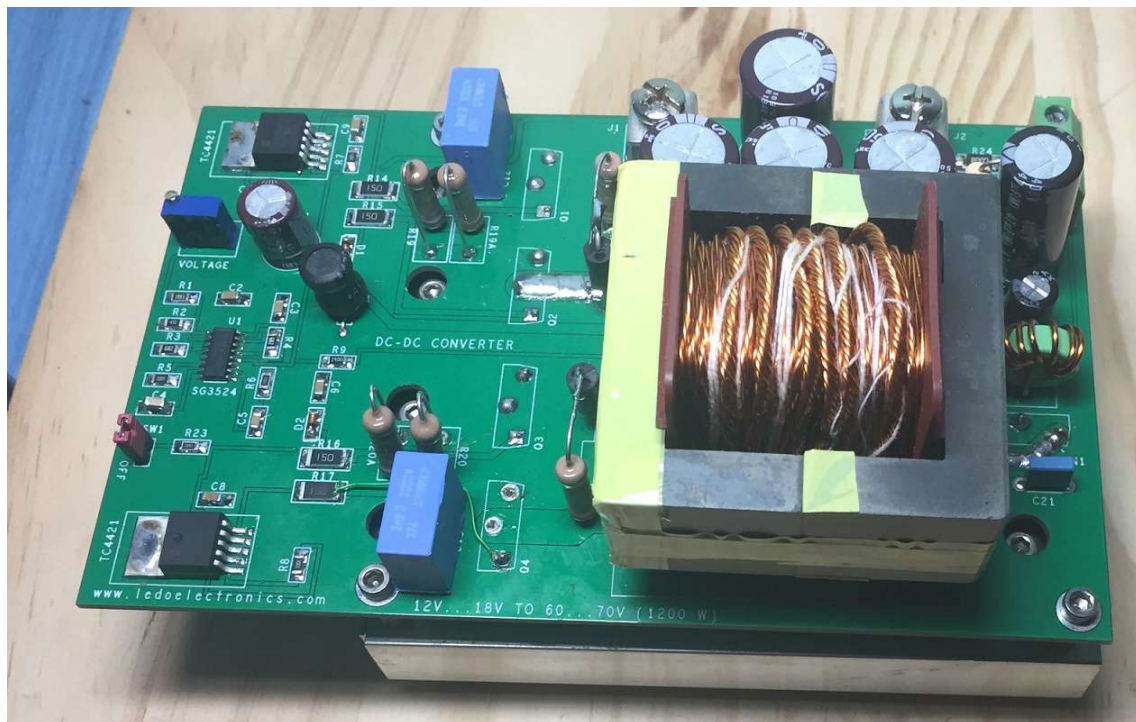


# 12V TO 60V 1KW DC-DC CONVERTER



**Note: It is still under development.**

Traditional DC-DC converter in push-pull configuration with mid-point transformer, based on the popular PWM regulator SG3524.

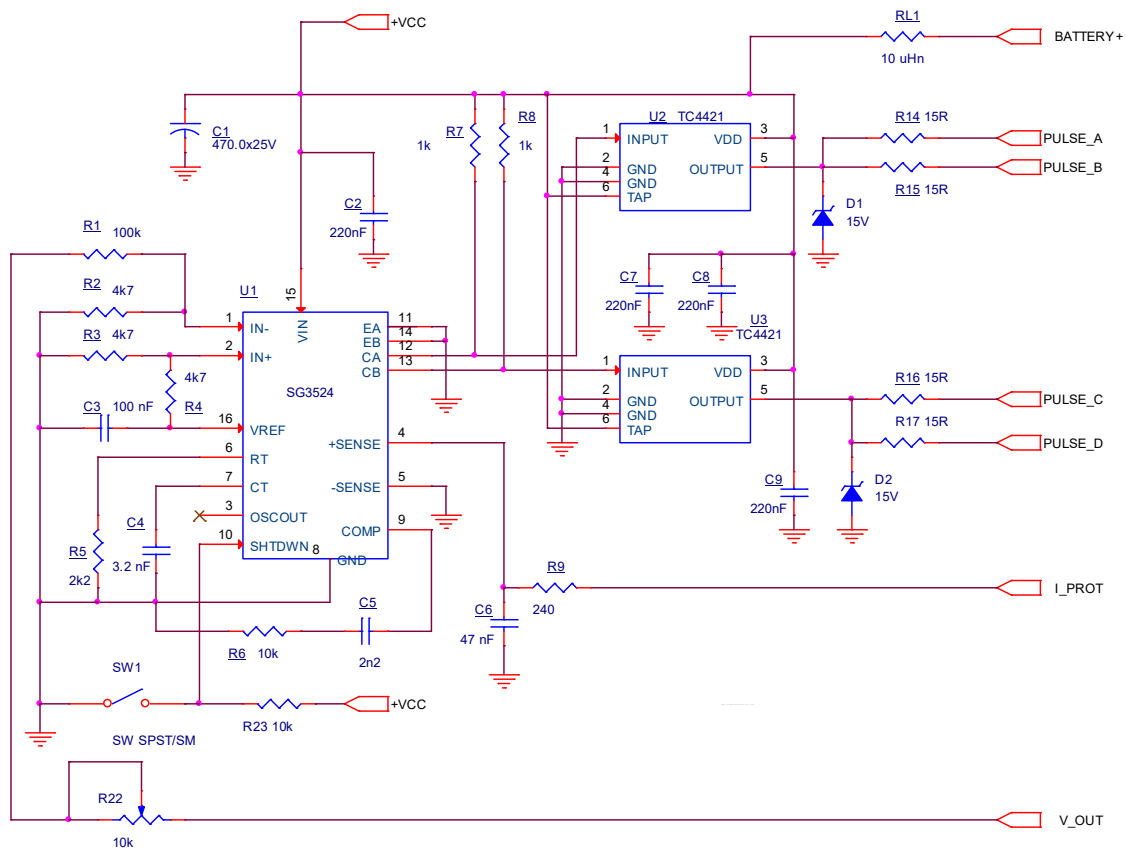


Fig.1. Control Circuit. SG3524 PWM Controller and Gate Drivers.

The SG3524 is used in its traditional configuration, at a frequency of 60 kHz, set by the R5 and C4 components.

The components RL1, C1, C2, C7, C8 and C9 constitute a low pass filter, which prevents the oscillations of the power circuit from altering the operation of the control part.

The converter output signal is applied to pin 1 (IN-), which constitutes a negative voltage feedback, for the stabilization of the output voltage. The R22 trimmer allows adjustment.

R9 and C6 filter the current protection signal, from the R24 shunt, connected in series with the load.

The shunt has been connected to the output of the converter, to reduce losses, since the current there is about 10 times less than in the primary of the transformer; This has the disadvantage that the protection only reacts to short circuits and overloads at the 60V DC output, and does not protect the converter against internal faults.

The SW1 switch allows the output power to be switched on and off, without the need to disconnect the power connections. SW1 must be closed for the circuit to be in the on state.

Importantly, we use the inverted outputs of the IC SG3524 (the signal from the collectors). For this reason, the gate amplifiers must invert the logical levels of the control signals, therefore the TC4421 circuits are applied, which are of the inverter type.

The TC4421 can be replaced by a push-pull stage with two bipolar transistors, in case the circuit ICs cannot be achieved.

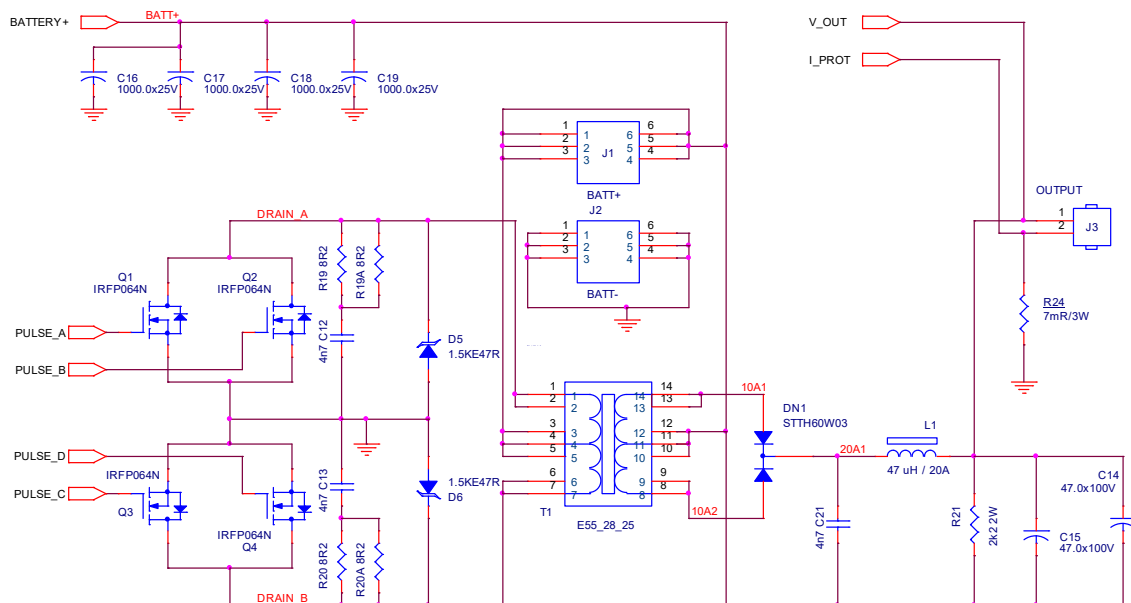


Fig.2. Power Circuit.

The power part consists of the bank of filtering capacitors, the switching MOSFETs, the high-frequency transformer T1, the output rectifier with its LC filter and the power input and output terminals.

At maximum power, the current through transistors Q1-Q4 can reach values above 100 A. For this reason we use two IRFP064 in parallel on each arm, and we protect them against over voltage, redundantly, with an RC snubber and with the TVS D5 (D6) diode, which limits the peaks to 47V.

The PCB mounting plate has been designed with the power tracks open, so that they can be tin-reinforced, and able to withstand the high levels of currents required.

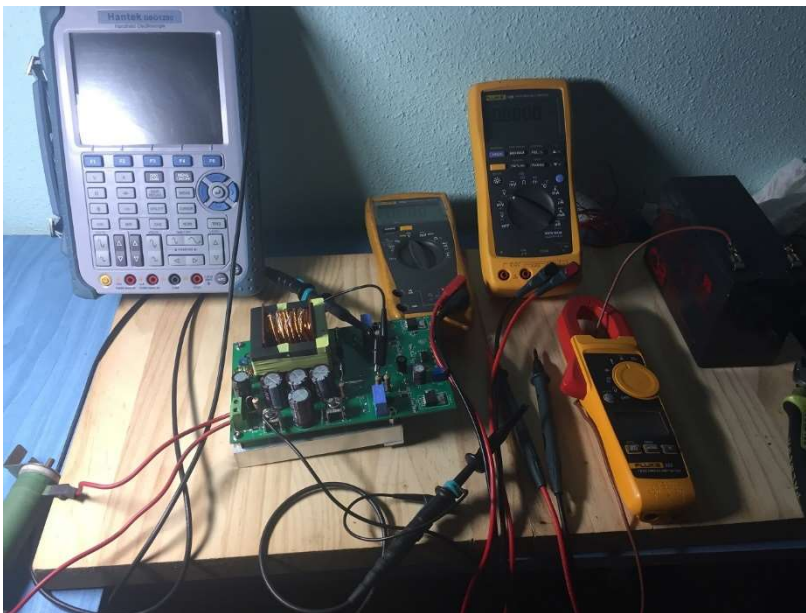
As you can see, the converter output has been connected in series with the battery; in this way the voltage at the output is the sum of both. This allows to increase the performance and the output power, since 20% of the energy is transmitted directly, without the need for conversion and does not pass through the T1 transformer.

For transformer T1 a ferrite core E55 / 28 / 25 of material N87 is used. The primary has four loops with a midpoint (2x2) of a total of 10 wires of 0.7 mm in parallel. The secondary has 32 turns with a midpoint (16x2), and in this case three 0.7 mm parallel wires are used.



Fig.3. Power Transformer.

## Pruebas preliminares



The first tests revealed the full functionality of the entire circuit, however, as the oscillograms show, there are great oscillations in each commutation, which shows that the transformer has not been manufactured to the required quality. As a result, the efficiency of the converter is only 75% when at least 80% was expected.

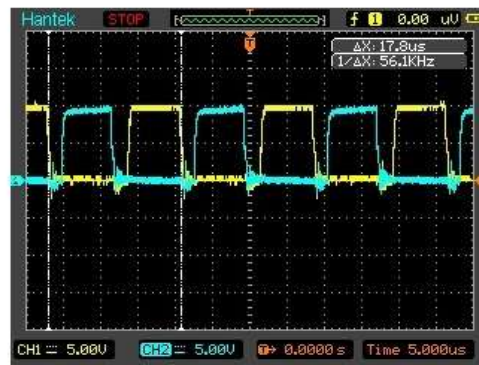
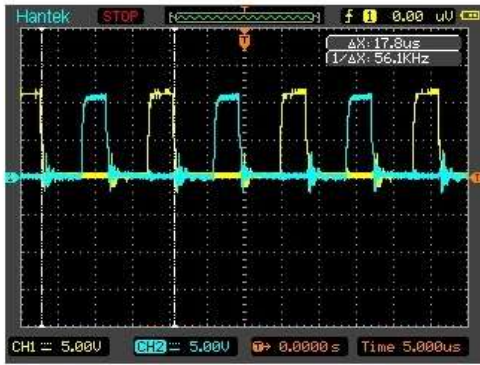


Fig.4. MOSFETs Gate Signals, for output current 2A and 12A.

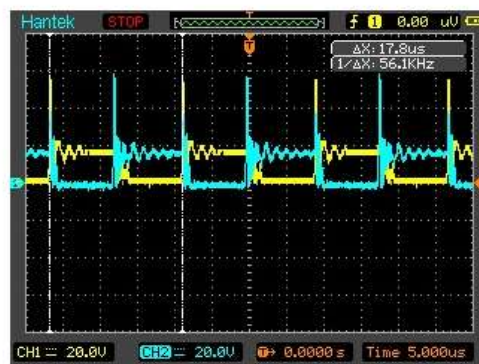


Fig.5. MOSFETs Drain Signals, for output current 2A and 12A.

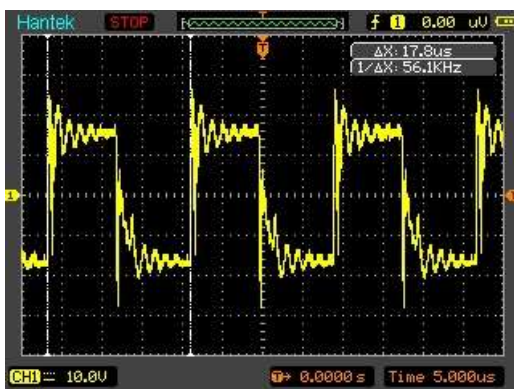


Fig.6. Primary winding Transformer Waveform.

**Conclusions:**

*The converter has been tested up to 15A output, which is equivalent to a power of 900 W. The short-circuit protection at the output has also been found to function properly.*

*Tin-reinforced PCB tracks withstand all current without overheating.*

*The heatsink used for testing is not sufficient to evacuate all heat at full power at steady state. It is recommended to increase its area, and the presence of a fan is mandatory.*

*It is necessary to improve the transformer, to increase the efficiency of the converter. Subsequent tests were performed using a 63x38x25 N87 toroid core, and the results improved substantially.*