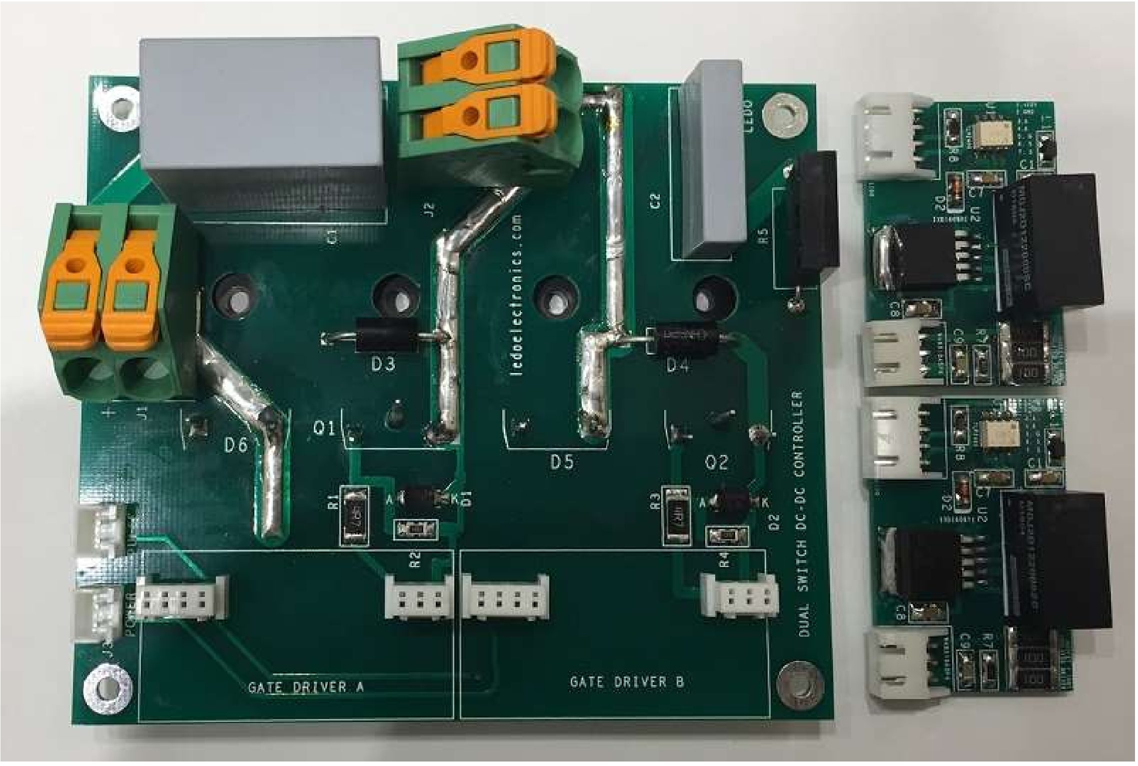
DUAL SWITCH DC-DC CONVERTER

Le-DC-DC-25



- **DC / DC forward converter with two switches and high frequency reduction transformer.**
- **Isolated output**
- **Output power: 5KW**
- **Switching frequency: 120 kHz.**

Designed as a regulating element of voltage and current of a welding machine, using very high quality components. It must be powered by a rectifier bridge with capacitive filter such as the **Le-ACDC-25** rectifier from Ledoelectronics.

It contains only the power stage and the gate amplifiers for the excitation of the two MOSFETS transistors. For its operation it requires a digital control system with a PWM output. Optionally you can count on analog inputs for the measurement of the current, the output voltage and the temperature of the power semiconductors.

The transformer and the components of the secondary rectifier are mounted separately, since the output current can reach 200 A in a sustained manner. In fig.1 the circuit corresponding to the primary part of the converter is shown.

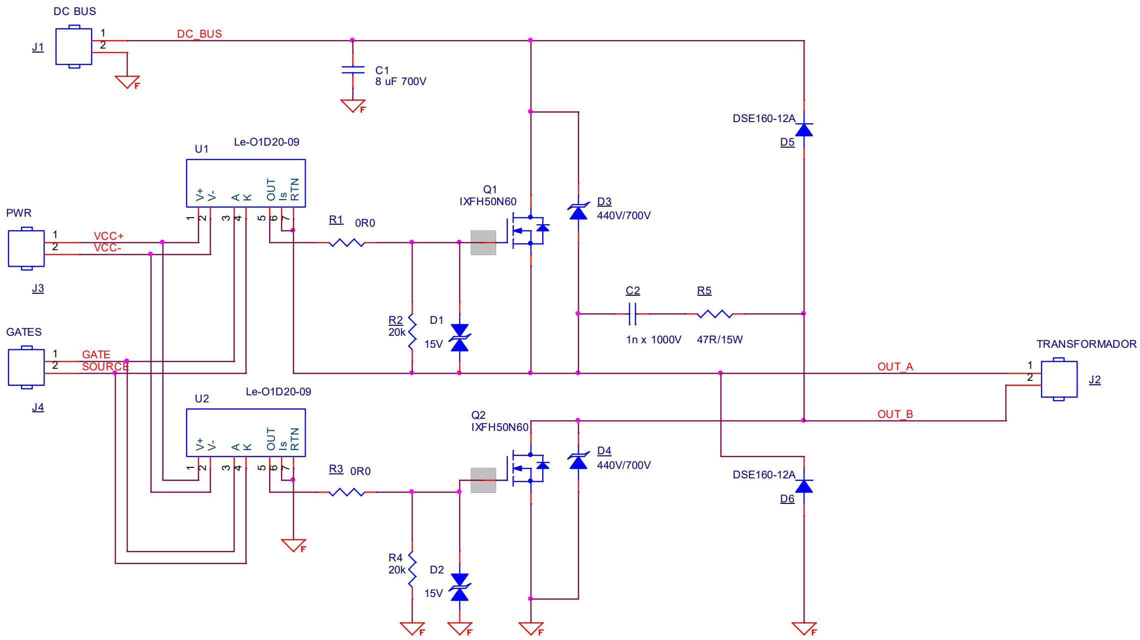


Fig.1. Primary part of the converter.

During the pulse time, the current flows through the transistors Q1, Q2 and the primary winding of the transformer, and at the same time the transfer of energy to the rectifier located in the secondary winding occurs at the output of the converter.

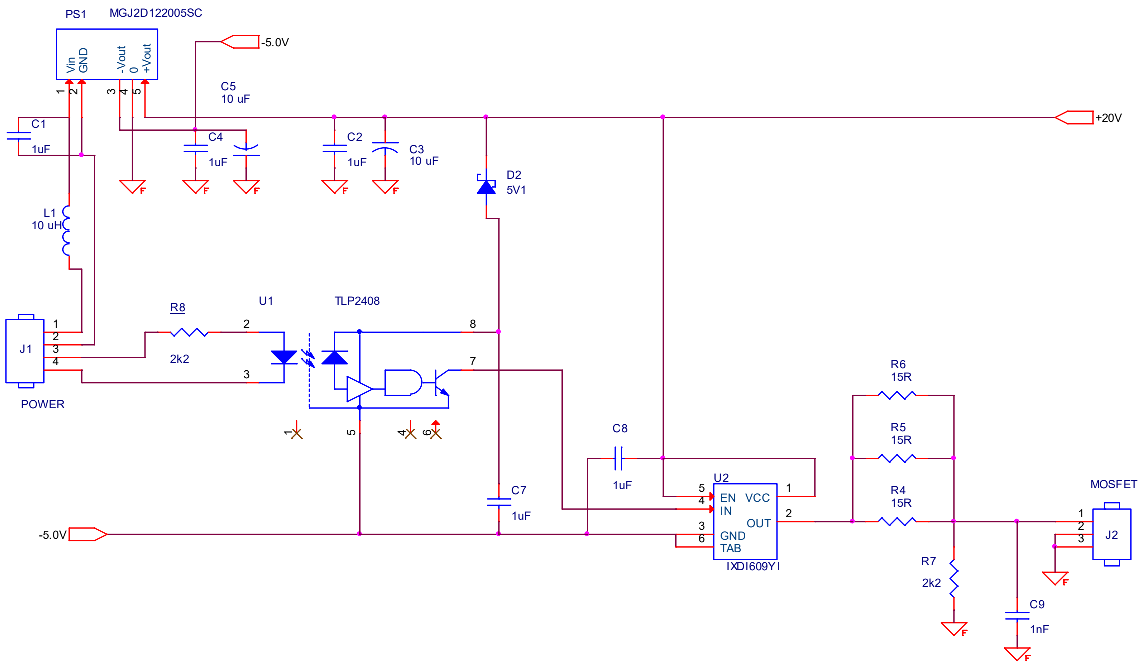


Fig.2. Ledoelectronics **Le-O1D20-09** non-inverting gate amplifier electric circuit diagram.

During the pause time, when the transistors are turned off, the energy stored in the transformer is returned to the power supply through diodes D5 and D6, which are fast recovery. During this time the reset of the transformer core occurs, so no auxiliary winding is required, to avoid saturation of the core.

Diodes D5 and D6 limit the voltage applied to the transistors to the power DC bus value, so they do not require individual Snubbers. However, it is necessary that the power supply be of very low impedance. The capacitor C1, with very low ESR value, performs the Snubber function on the power bus, decreasing the voltage oscillations, and the overvoltages in the MOSFETS.

The diodes TVS D3 and D4, are responsible for limiting the amplitude of the voltage peaks that arise during the process of switching off the transistors, caused by the parasitic inductances of the conductors and components of the circuit.

The TVS diodes D1 and D2 protect the gates of the transistors, limiting the voltage to ± 18V.

Resistors R1 and R3 allow limiting the on and off speed of the transistors, so as not to exceed the maximum value of dV / dt allowed. It must be taken into account, as shown in fig.2, that the gate pulse amplifier module **Le-O1D20-09** already includes grid resistors (R4, R5 and R6).

As can be seen in the picture, the power semiconductors Q1, Q2, D5 and D6 are arranged in such a way that they can all be screwed to a heat sink on the underside of the plate.

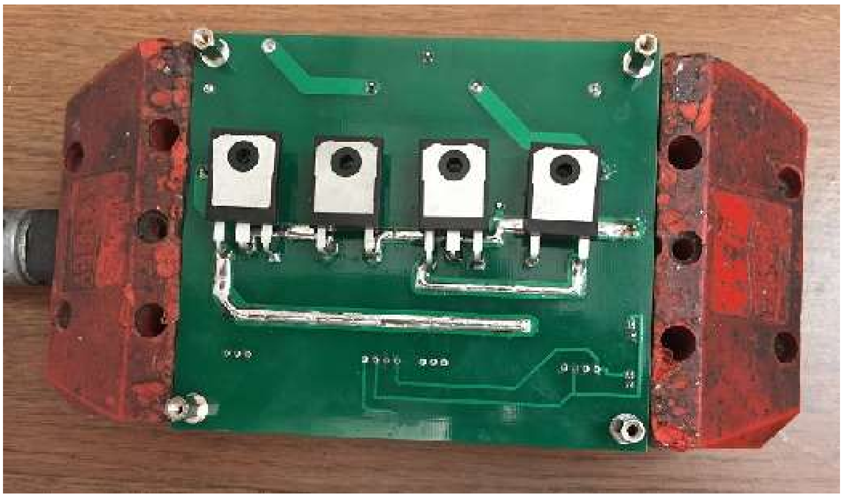


Figure 3 shows the connection of the high frequency transformer, and the entire circuit corresponding to the rectifier of the secondary part.

During the pulse time (time in which the MOSFETS drive), the energy is transferred from the primary to the secondary of the transformer, and in turn to the output by the high current fast diode D7. In the pause time, D7 is blocked and the energy stored in the shock coil L1 causes the current to continue to flow through the load, now through the diode D8.

The voltage divider formed by R6 and R7 allows to sample the output, to provide information to the control system about the magnitude of the welding voltage in real time.

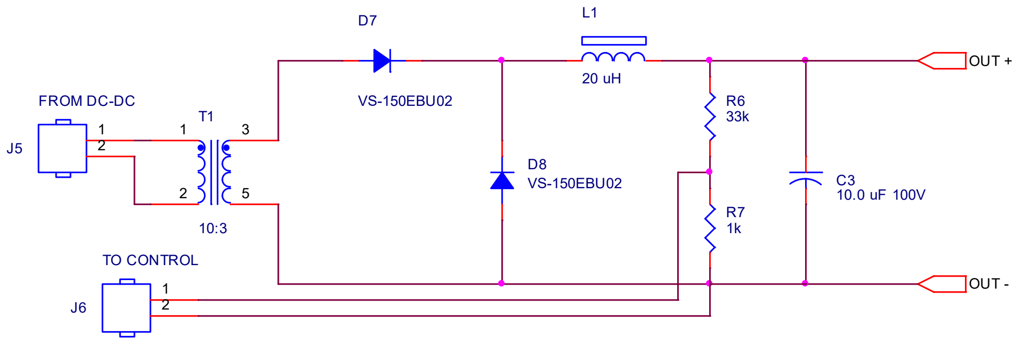


Fig.4. Transformer and output rectifier

The power dissipated in each of the diodes D7 and D8 is about 80 W for an output current of 200 A, so it is necessary to ensure efficient heat extraction. If for reasons of portability you do not want to resort to water cooling, then it is necessary to implement forced air cooling with fan or turbine and passive copper or aluminum heatsinks of sufficient size. In any case, it is recommended to measure the temperature and stop the operation of the equipment due to overheating.

Transformer T1 has been manufactured using an Epcos ferrite ring of type B64290L0699 material type N87. This ring has an outer diameter D = 63 mm, an inner diameter d = 38 mm and a height h = 25 mm.

The primary has 12 turns and the secondary one with 3 turns. The primary wire must withstand 25A, and can be wound using two 1.5mm stranded wires, while the secondary wire must withstand 200A at a 60% working rate, the cross section of the secondary wire must be not less than 36 mm^2.

The L1 coil is fundamental for the stability of the arc and the quality of the welding. Its inductance L is calculated according to [1] by the formula:

$$L \geq \frac{U_2.\gamma_{min}(1-\gamma_{min})}{2.I.f};$$

Where:

L – is the inductance of the coil in Hn;

U_2 – Transformer secondary voltage in V;

γ_{min} – Minimum value of the duty cycle of the DC-DC converter. It must not be less than 0.15, to guarantee the work mode in continuous current;

I – Minimum welding current in A;

f – Working frequency of the DC-DC converter in Hz;

$$L \geq \frac{80 * 0.15(1-0.15)}{2 * 10 * 60000} = 8.5\ \mu Hn;$$

A core with an air gap should be used, with enough size to avoid saturation at 200A.

Referencias:

1. *"Osnovi preobrazovatelnoi texniki". Rudenko V.S, Senko V.I, Chizhenko I.M. Moscow 1980.*
2. *Data sheet of all the components used.*