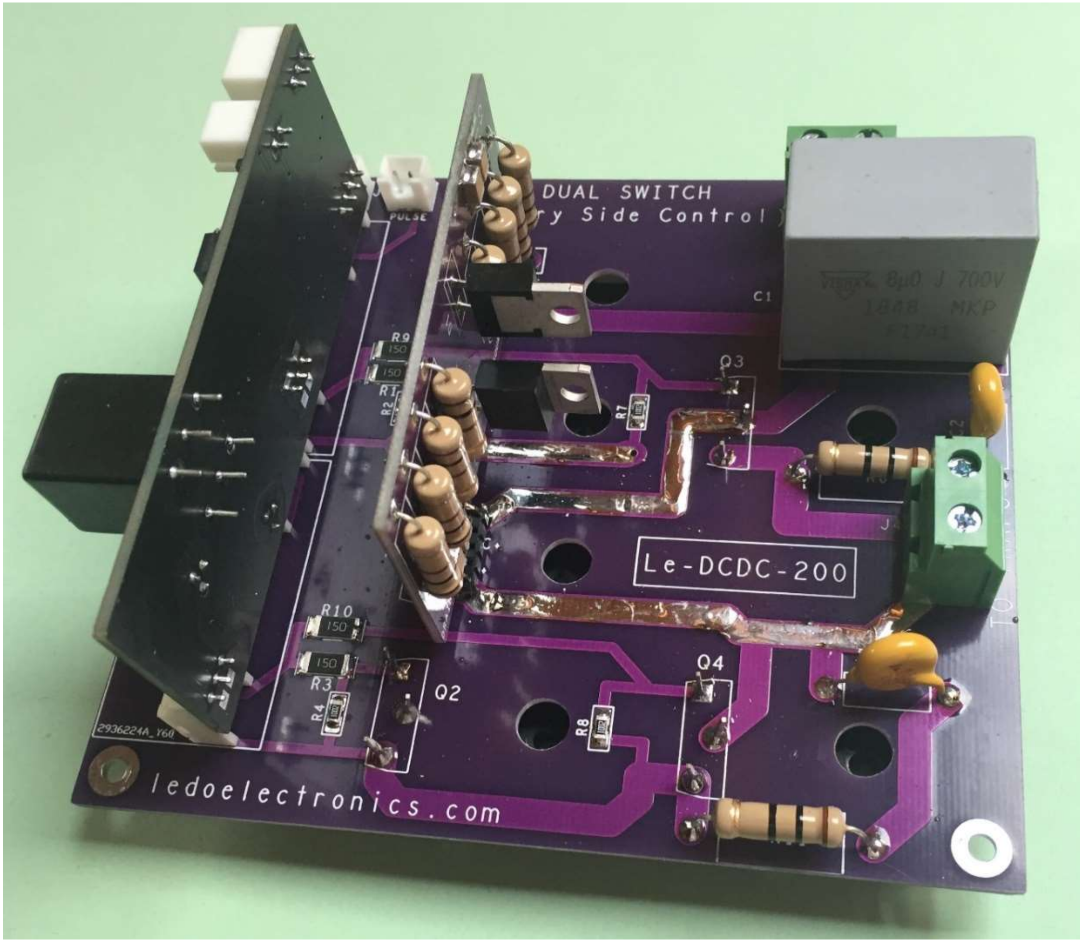
DUAL SWITCH DCDC CONVERTER
Le-DCDC-200



- **Dual Switch DC/DC forward converter (primary side only)**
- **Requires transformer and secondary rectifier**
- **Output power: 5KW**
- **Switching frequency: 30…120 kHz.**

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

It contains only the power stage and the gate amplifiers for driving the two MOSFETS or IGBTs. For its operation it requires a digital control system with a PWM output.

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Optionally, it can have analog inputs for measuring the current, the output voltage and the temperature of the power semiconductors.

The transformer and secondary rectifier components are mounted separately, as the output current can reach 200A sustained. Fig.1 shows the circuit corresponding to the primary part of the converter.

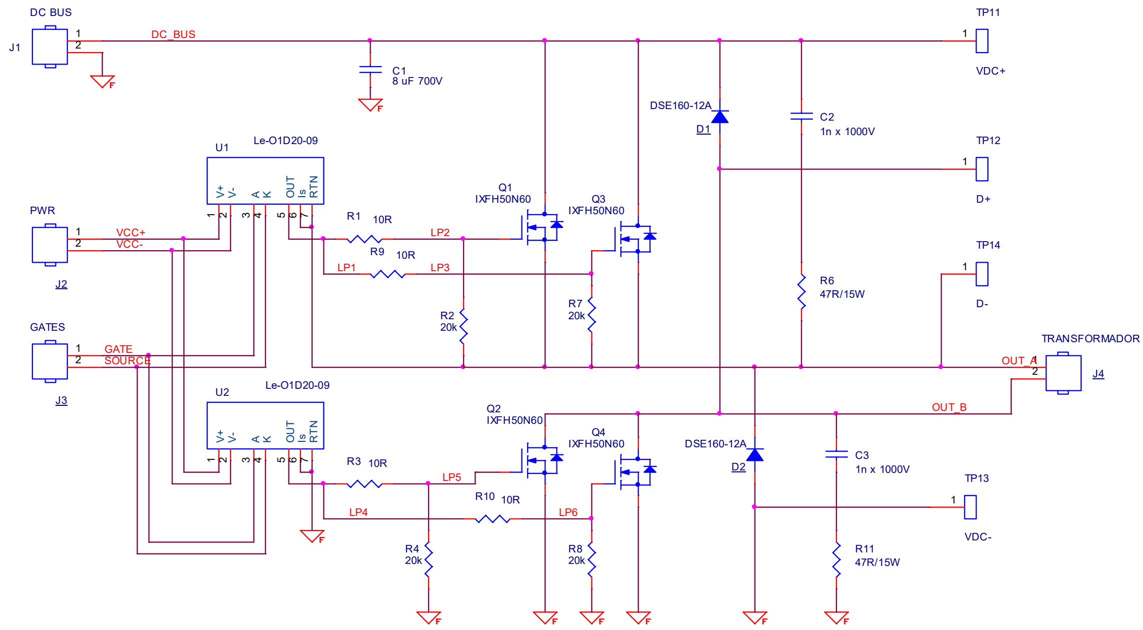

Fig.1.Converter schematics.

During the pulse time, the current circulates through the transistors Q1, Q2, Q3, Q4 and the primary winding of the transformer, and the energy is transferred to the secondary rectifier located in the secondary winding.

During the pause time, when the transistors are turned off, the energy stored in the transformer is returned to the power supply through diodes D1 and D2, which are fast recovery. During this time, the reset of the transformer core occurs, so no auxiliary winding is required to avoid core saturation.

Diodes D1 and D2 limit the voltage applied to the transistors to the value of the DC bus supply, so they do not require individual snubbers. However, it is necessary that the power supply be of very low impedance. The capacitor C1, with a very low ESR value, acts as a Snubber on the power bus, reducing voltage oscillations and overvoltage in the MOSFETS.

In addition, the board has additional snubber networks mounted on a vertical submodule, which guarantee reliable operation of the transistors in the worst circumstances.

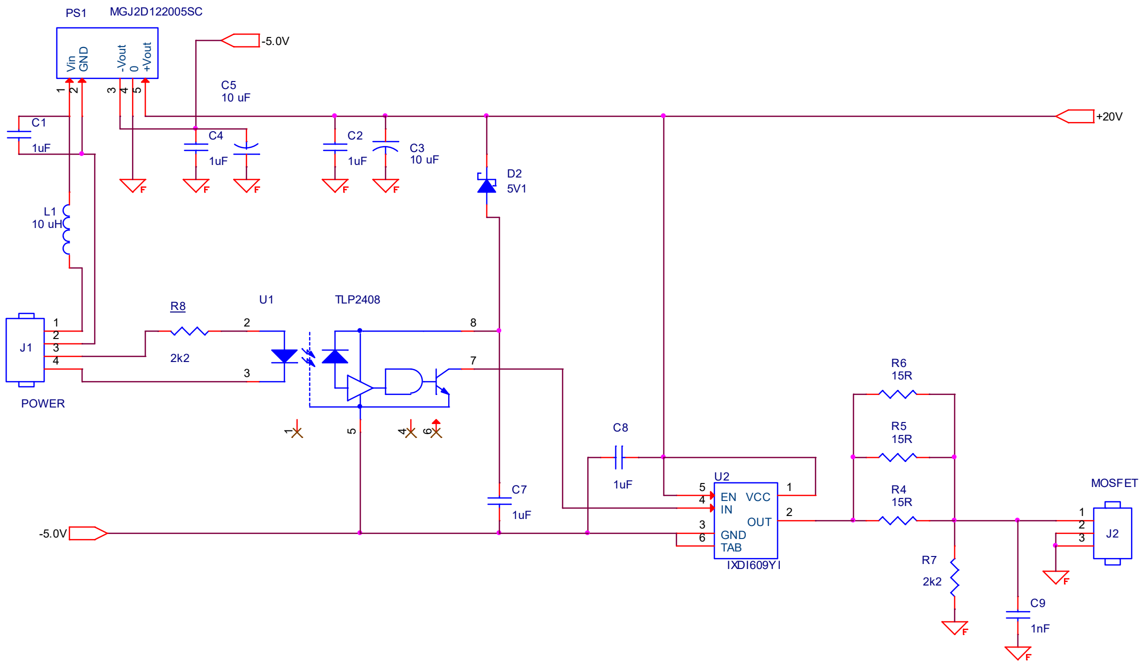

Fig.2. Ledoelectronics Le-O1D20-09 Gate Driver Schematics.

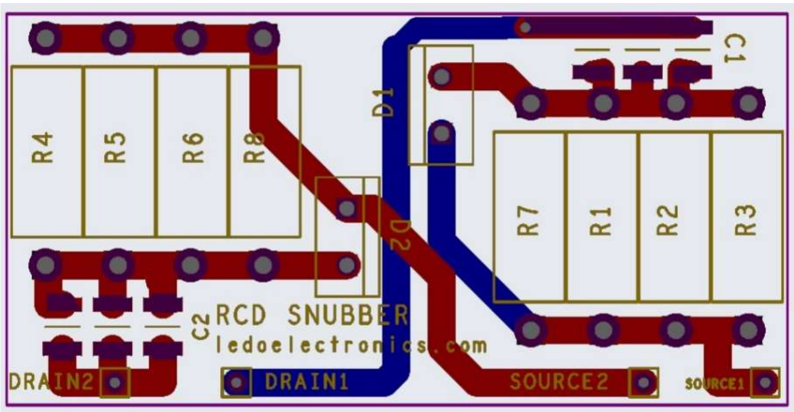

Fig.3. RCD Snubber.

Resistors R1, R3, R9, and R10 balance the control of the transistors in parallel, and allow to limit the speed of turning the transistors on and off, so as not to exceed the maximum value of dV/dt allowed.

As can be seen in the photo, the power semiconductors Q1, Q2, Q3, Q4, D5 and D6 are arranged in such a way that they can all be screwed to a heat sink from the bottom of the board.

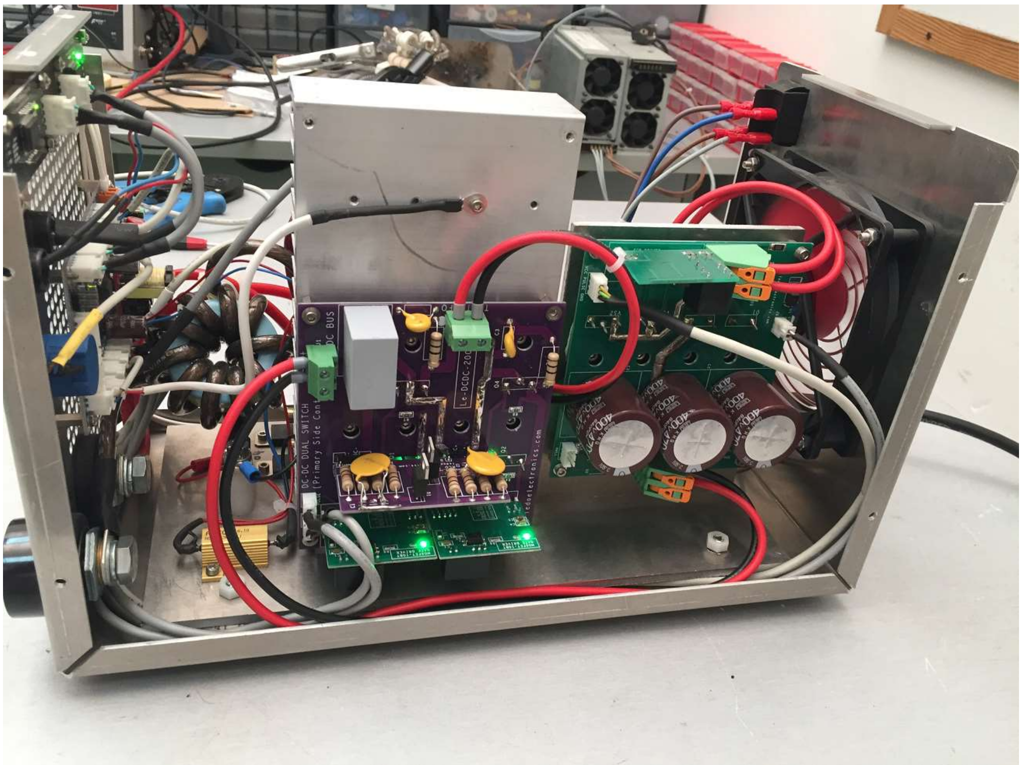

Fig.4. Example of use in the Ledoelectronics L-200 arc welding prototype.

Fig.5 shows the connection of the high frequency transformer, and all the circuit corresponding to the rectifier of the secondary part.

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

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

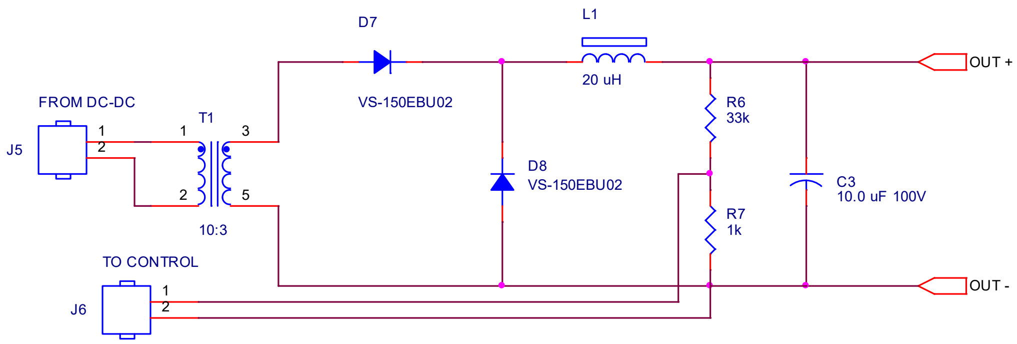

Fig.5. Transformer and secondary rectifier. (not included).

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 removal. If, for portability reasons, water cooling is not desired, then it is necessary to implement forced air cooling with a fan or turbine and passive copper or aluminum heat sinks 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 Epcos ferrite ring 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 with 3 turns. The primary wire must withstand 25A, and can be wound using two 1.5mm twisted wires, while the secondary wire must withstand 200A at 60% duty cycle, the cross section of the secondary wire must be no less than 36 〖 mm〗 ^2.

The L1 coil is critical to arc stability and weld quality. 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;

$\gamma_{min} -$ Minimum value of the duty cycle of the DC-DC converter. It should not be less than 0.15, to ensure DC working mode;

$I -$ Minimum welding current in A;

$f -$ DC-DC converter working frequency in Hz;

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

An air gap core should be used, sized enough to avoid saturation at 200A.

Referencess:

1. *"Osnovi preobrazovatelnoi texniki". Rudenko V.S, Senko V.I, Chizhenko I.M. Moscú 1980.*
2. *Used components datasheets.*