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MOSFETS IN SERIES FOR HIGH VOLTAGE POWER CONVERTERS

High voltage power supplies have the limitation of the maximum voltage of available MOSFETs (1000 V). Because silicon area of high voltage Mosfets increases with the square of the voltage, often is more efficient to use a dual fly-back or a dual forward converter than a single driven one.

However, dual converters have the added complexity of the gate drive circuit of the positive side MOSFET. **Figure 1**, shows a simpler arrangement using 2 MOSFETs in series.
Q1 must withstand the Vdc voltage. Q2 must withstand the reflected voltage of the secondary during turn off time.

Supposing Q1 is on. R1 keeps C1 and Q2 gate charged, so Q2 is also on. R1 value must be low enough to compensate the leakage of ZD1.

When Q1 turns off, voltage in its drain increases fast, but the gate is discharged by the charging current of C1; when ZD1 conducts, the gate is fully discharged. Q1 drain voltage is clamped to Vdc by ZD1 and D1. Then Q2 will withstand the fly-back or reflected voltage of the transformer. Voltage spikes owing to the leakage inductance are limited by D2, C2, R4.

When Q1 turns on, C1 discharging current keeps the gate conducting. R3 limits de peak of the charge / discharge currents.

Take C1 > Vgs · Qg / Vdc where Vgs is the gate voltage (i.e. 10V) and Qg the total gate charge.

The values shown correspond to a 250 W forward converter working up to 400 V using 500 V MOSFETs.

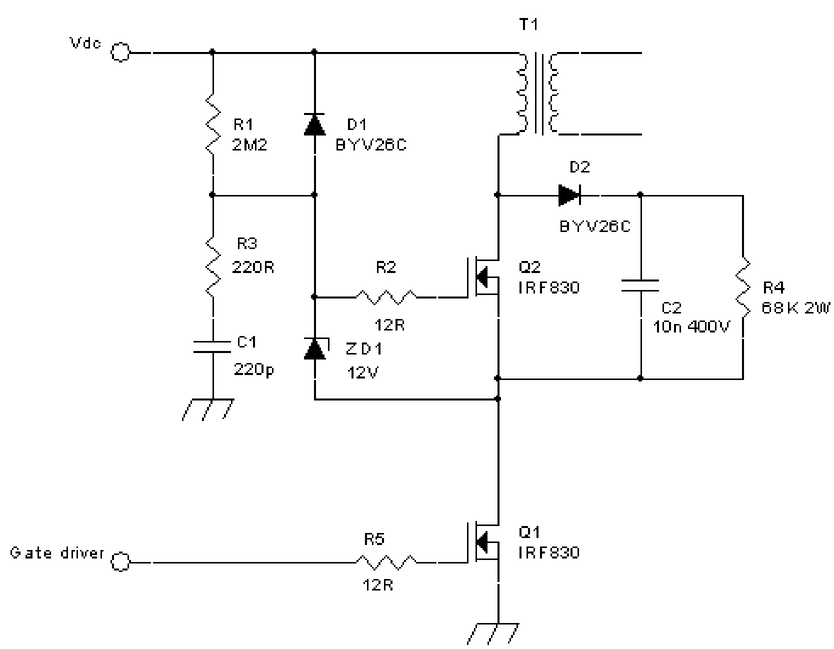

Fig. 1

Figure 2 shows another circuit where the Vdc voltage is higher than the voltage of each individual MOSFET. The example corresponds to a 80 W buck converter which works up to 1700 V DC using 1000 V MOSFETs. The converter was used as a voltage conditioner for a standard fly-back converter.

In static on conditions, Q2 gate is kept at half Vdc by R1, R8. Q1 drain is kept at half Vdc as R9, R10 provide a current much higher than the leakage current of Q2, Q1. Q2 adjusts its gate voltage automatically to keep its gate at ½ Vdc: If the source goes low, gate voltage increases, making Q2 more conductive and if the source goes high, the gate voltage decreases.

The snubbers in parallel with the MOSFETs are used not only to limit overvoltage spikes but to make both MOSFETs to share the voltage during turn off and turn on. They also limit the dV/dt at turn off. So C2 and C3 must be higher than the drain to source capacitance of the MOSFETs. C1 has the same purpose than in the previous circuit. You may need to use resistors in series, instead of single resistors, for them to withstand the high voltages of the circuit.

More than two MOSFETs can be used in series using the same concepts.

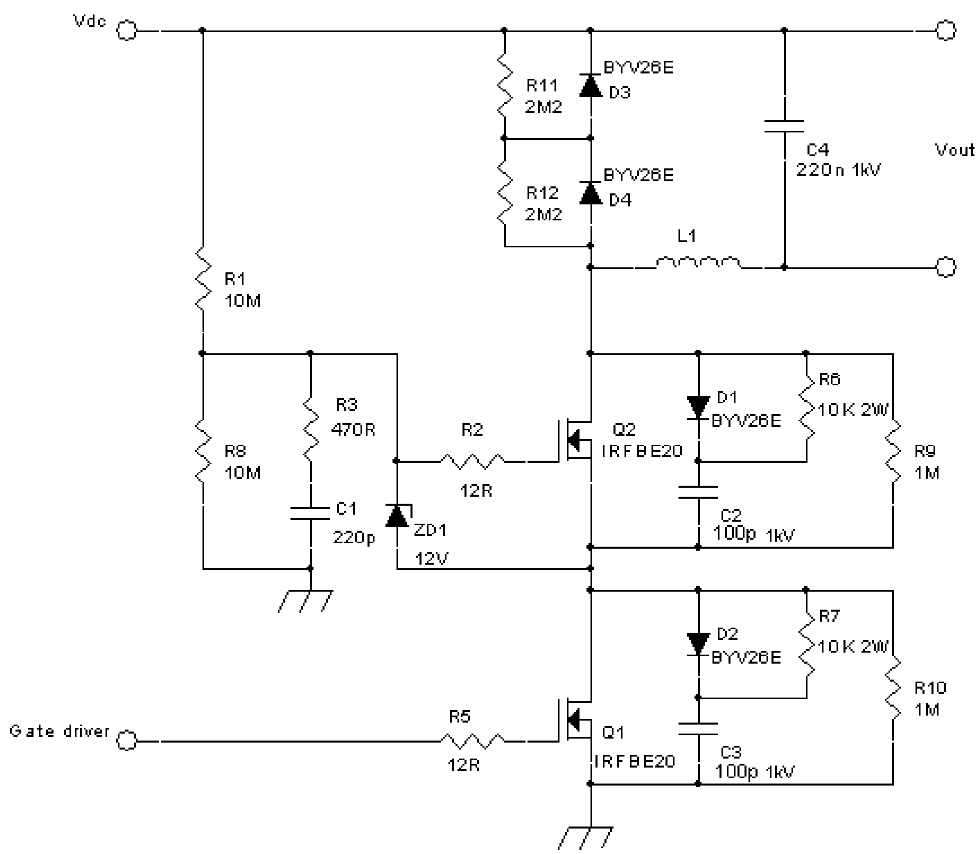

Fig. 2