(if an RCD type is used, see "Clamp network"). Besides, a lower reflected voltage often leads to a primary-to-secondary turns ratio closer to 1:1. A positive side effect of that is a better magnetic coupling between windings, which, in turn, helps reduce leakage inductance. On the other hand, consider that a lower reflected voltage involves higher primary peak currents at heavy load.

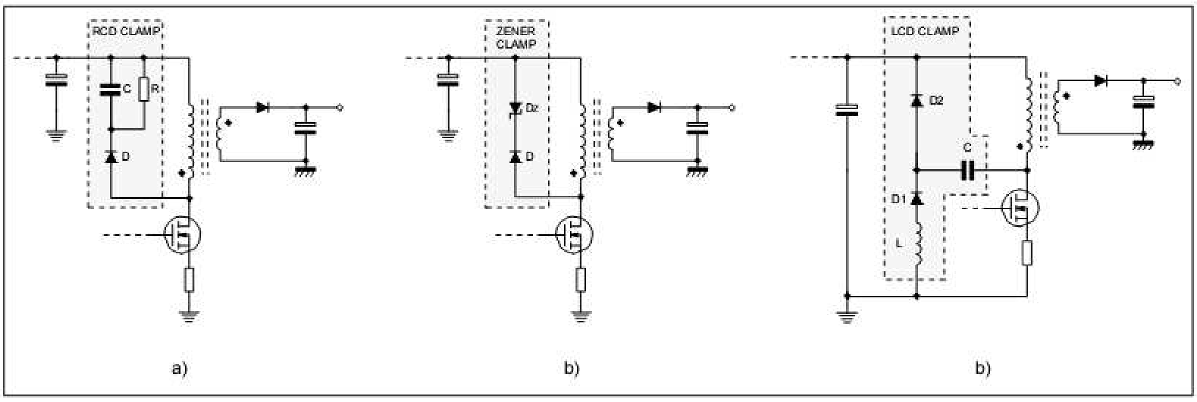
Clamp network.

Typically, the spike due to the transformer's leakage inductance is limited by an RCD clamp (see fig. 12a). Its action should be very light so as to have a spike as large as possible, consistently with the need of never exceeding the voltage rating of the MOSFET. This will optimize energy transfer from primary to secondary. A low leakage inductance of the transformer is, of course, extremely helpful.

RCD clamps dissipate power even under no-load conditions: there is always the reflected voltage across the clamp resistor (R). To reduce clamp losses to a negligible level at light load, the use of a zener clamp (see fig. 12b) is recommended whenever possible. Such a circuit gives also a well defined clamping level but, on the other hand, dissipates more power at full load. Its use is therefore limited to low power applications. Furthermore, a zener clamp can be more expensive than an RCD type.

An alternative to these solutions can be the use of a non-dissipative clamp like the LCD one shown in fig. 12c, which helps also reduce turn-off losses in the MOSFET. This circuit recovers the majority of the leakage inductance energy by transferring it back onto the input voltage rail. There is just a little power dissipation on the two diodes and the inductor. However, there is a slight increase of the conduction losses in the MOSFET at heavy load and, besides, the circuit is quite expensive and not easy to design.

Figure 12 - Possible clamp circuit topologies



Whatever the clamp circuit topology is, the selection of the components is not trivial but needs special care to avoid annoying problems.

The capacitors should be low-loss type (with polypropylene or polystyrene film dielectric) to reduce power dissipation and prevent overheating due to the high peak currents they experience.

The blocking diodes must be not only very fast-recovery but also very fast-turn-on type. They should be rated for repetitive peak currents greater than Ippk and their voltage rating must be adequate but not much higher than necessary. For a given diode type, the higher its breakdown voltage is, the longer its turn-on time will be. This leads to higher turn-on losses and larger overvoltage spikes, extending above the clamp level, on the MOSFET's drain.

The zener diode must have an adequate power handling capability in both transient and steady state operation. The zener voltage should be approximately 50% higher than the reflected voltage so as not to have too high power dissipation at heavy load. A transient voltage suppressor (Transil) can be effectively used in place of zener diodes. Table 4 lists some recommended devices available from ST: BZV and 1N53xx types are zener diodes, all the others are Transil. SM15Txx devices are for surface mount assemblies.