5 high-side MOSFET gate drive topologies

Basic block diagram of a floating gate drive supply

Key features:
- Full gate control for indefinite periods of time.
- Cost impact of isolated supply is significant (one required for each high side MOSFET)
- Level shifting a ground referenced signal can be tricky. Level shifter must sustain full voltage, switch first with minimal propagation delays and lower power consumption.
- Opto isolators tend to be relatively expensive, limited in bandwidth and noise sensitive

The floating supply provides a voltage that is referenced with respect to the source terminal of the MOSFET. Usually this supply is a dual supply providing 15 V to switch ON the MOSFET and – 15 V to switch the MOSFET OFF. The gate drive provides the current to rapidly charge and discharge the gate capacitance of the MOSFET in order to allow for fast switching. The level shifter or optoisolator provides galvanic isolation of the control signal between the control (not shown) and the power stage above. The low-side device is another MOSFET that is used complementary to the high-side device in order to switch the load ON and OFF. A load can also be positioned in series with the high-side MOSFET.
5 high-side MOSFET gate drive topologies

Basic circuit of a pulse transformer as a gate drive

Key features:
- Simple and cost effective but limited in many respects
- Operation over wide duty cycles requires complex techniques.
- Transformer size increases significantly as frequency decreases.
- Significant parasitics create less than ideal operation with fast switching waveforms
5 high-side MOSFET gate drive topologies

Basic circuit of a charge pump

Key features:
- Can be used to generate an over-rail voltage controlled by a level shifter or to pump the gate when MOSFET is turned ON.
- In the first case, the problems of a level shifter, have to be tackled.
- In the second case, turn on times tend to be too long for switching applications.
- In either case, gate can be kept ON for an indefinite period of time.
- In-efficiencies in the voltage multiplication circuit may require more than two stages of pumping.
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Basic circuit of a bootstrap gate drive

Key features:
- Simple and inexpensive with some of the limitations of the pulse transformer, duty cycle and on-time are both constrained by the need to refresh the bootstrap capacitor.
- If the capacitor is charged from a high voltage rail, power dissipation can be significant.
- Requires level shifter with its associated difficulties.
5 high-side MOSFET gate drive topologies

Basic circuit of a carrier drive

Key features:
- Gives full gate control for an indefinite period of time but is somewhat limited in switching performance. This can be improved with added complexity.