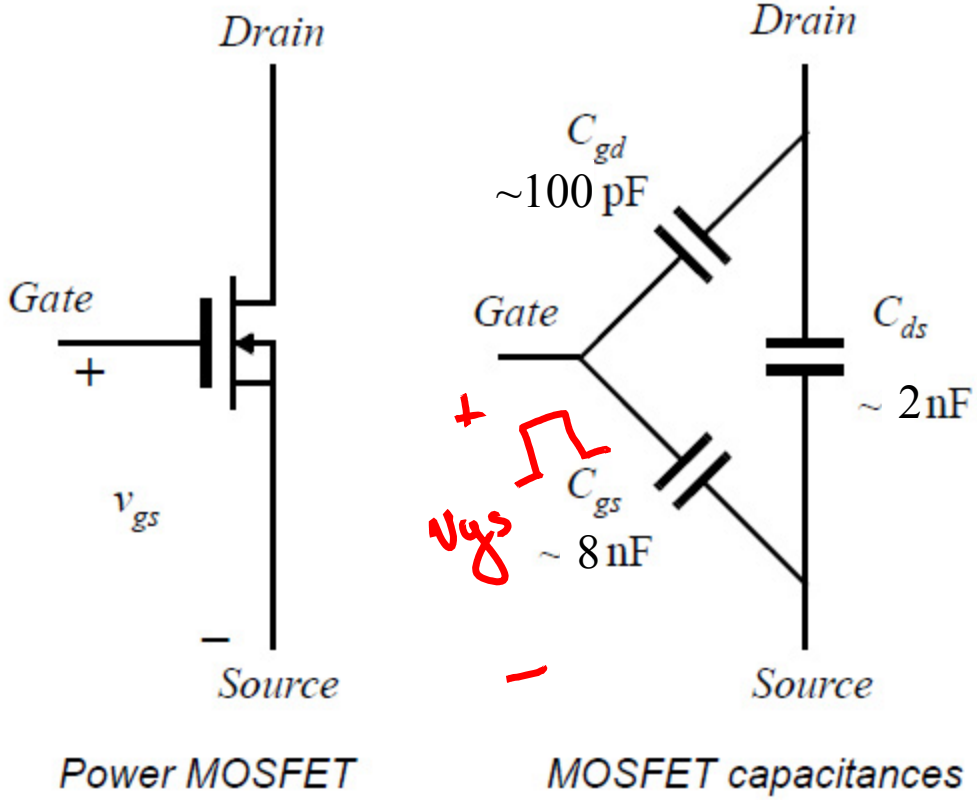
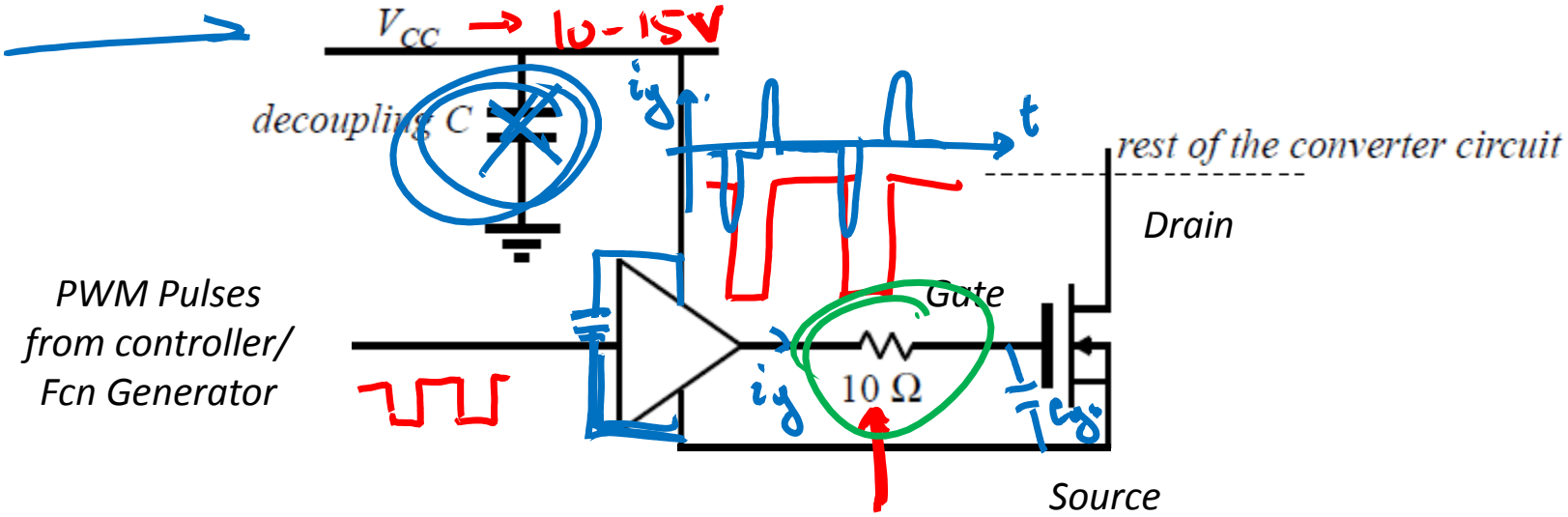
Driving a Power MOSFET Switch



Power MOSFET MOSFET capacitances

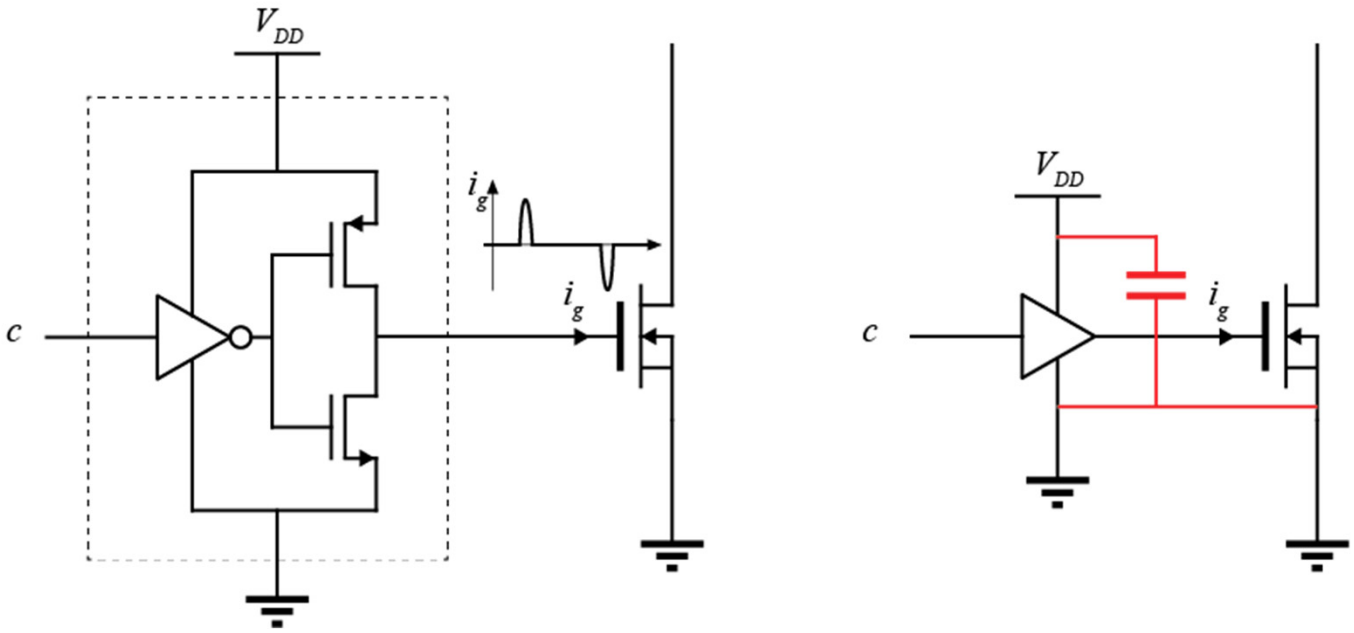
- MOSFET is off when $v_{gs} < V_{th} \approx 3$ V
- MOSFET fully on when v_{gs} is sufficiently large (10-15 V)
- Warning: MOSFET gate oxide breaks down and the device fails when $v_{gs} > 20$ V.
- Fast turn on or turn off (10's of ns) requires a large spike (1-2 A) of gate current to charge or discharge the gate capacitance
- MOSFET gate driver is a logic buffer that has high output current capability

Driving a Power MOSFET Switch



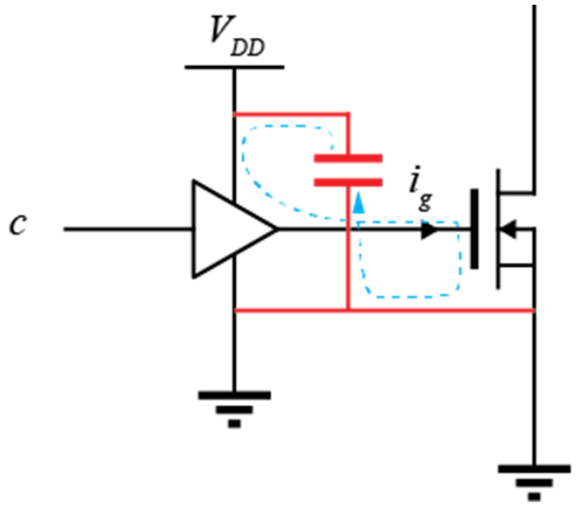
- MOSFET gate driver is used as a logic buffer with high output current (~1.8 A) capability
- The amplitude of the gate voltage equals the supply voltage *VCC*
- Decoupling capacitors are necessary at all supply pins of LM5104 (and all ICs)
- Gate resistance used to slow dv/dt at switch node

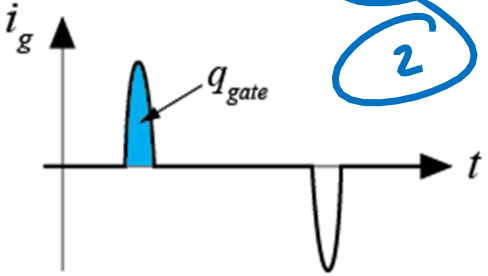
Gate Drive Implementation



- Gate driver is cascaded half-bridges of increasing size to obtain quick rise times
- Reminder: keep loops which handle pulsating current small by decoupling and making close connections

Capacitor Sizing – Pulsed Caps





Most Important loop in Power converter layout

1 Power loop

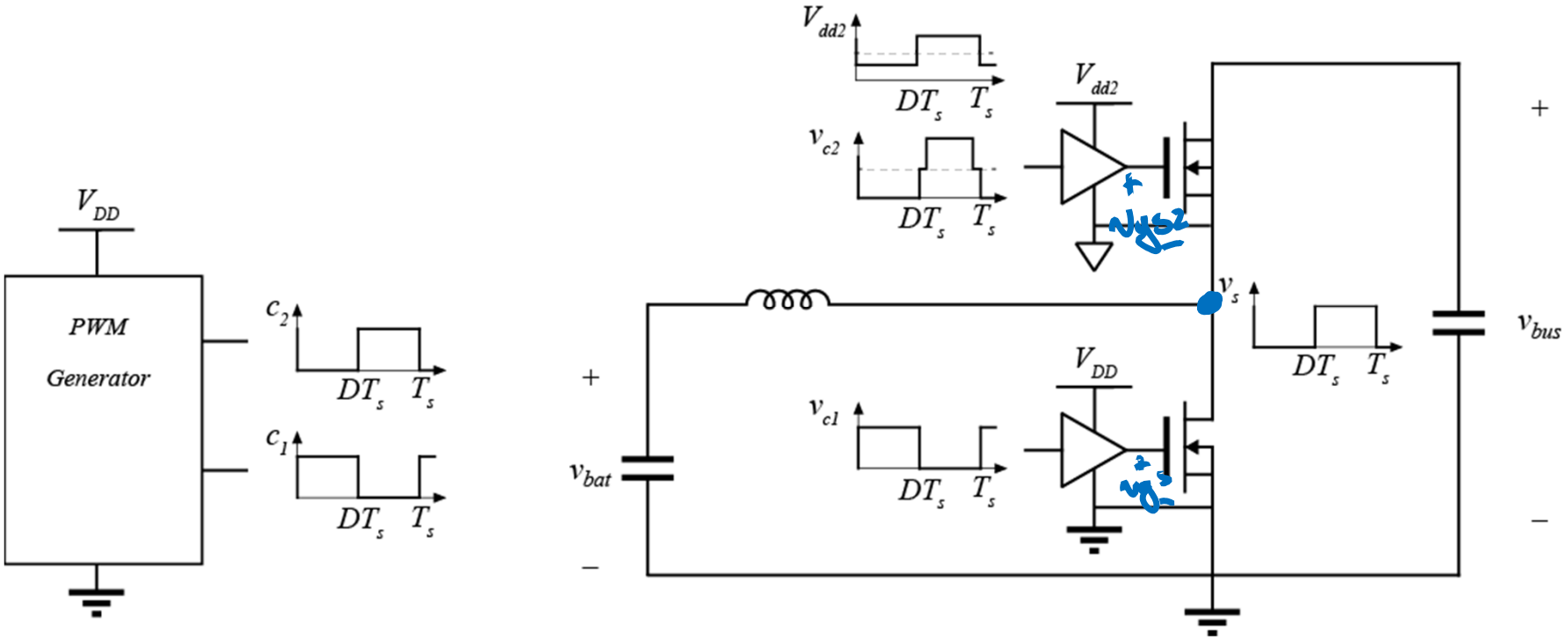
2 Each gate drive loop

$$\frac{q_{gate}}{\Delta V_{DD}} = C$$

everything else

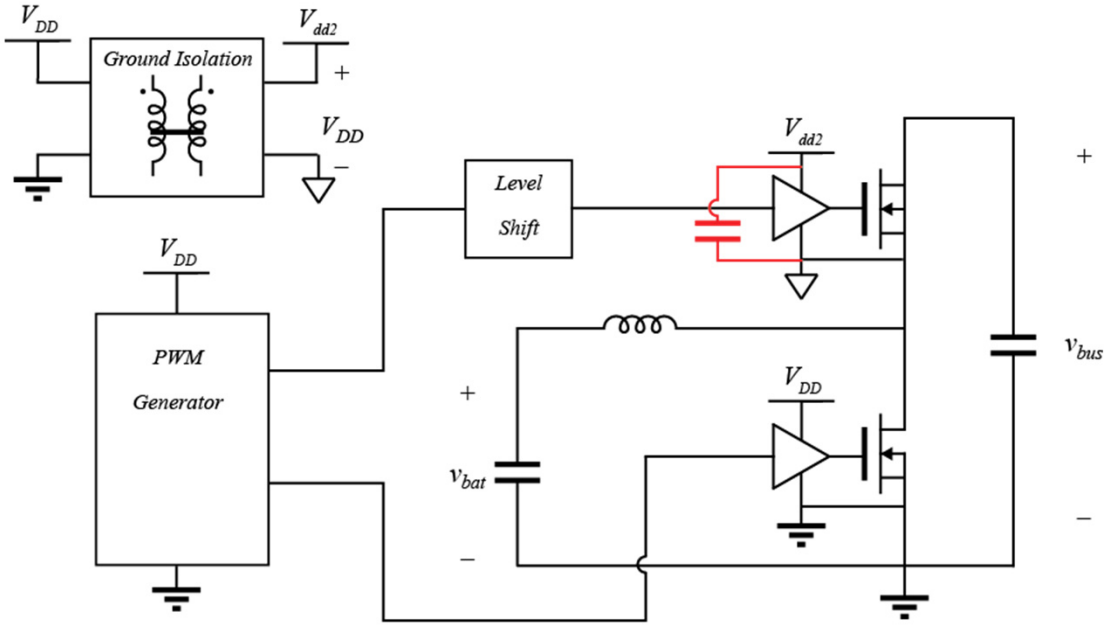
- Area of current pulse is total charge supplied to gate of capacitor
- All charge must be supplied from gate drive decoupling capacitor

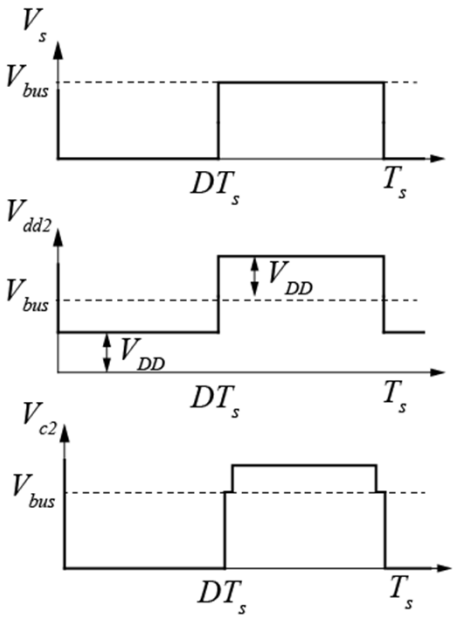
High Side Signal Ground



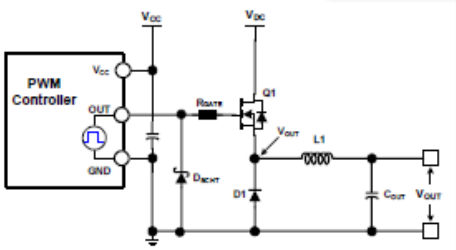
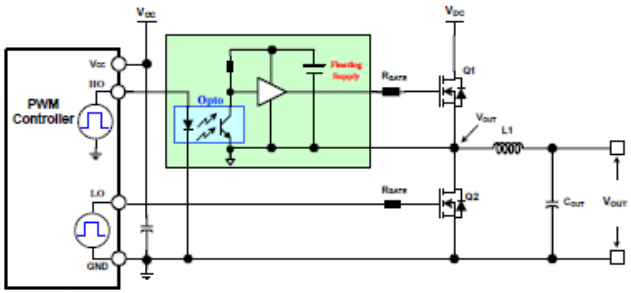
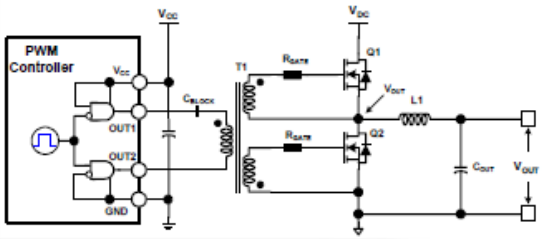
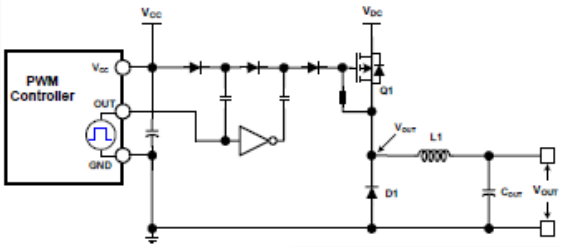
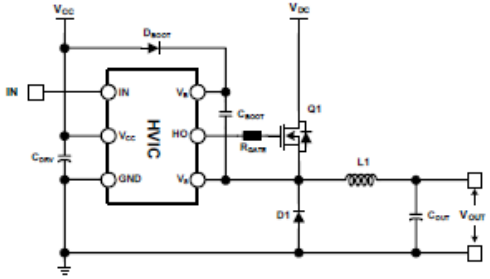
- Gate driver chip must implement v_{gs} waveforms
- Issue: source of Q_2 is not grounded

Generating Floating Supply





- Isolated supplies sometimes used; Isolated DC-DC, batteries
- Bootstrap concept: capacitor can be charged when V_s is low, then switched

Direct Drive		Easiest high-side application the MOSFEF and can be driven directly by the PWM controller or by a ground referenced driver, but it must meet two conditions, as follows: $V_{CC} < V_{GS,MAX}$ and $V_{DC} < V_{CC} - V_{GS,Miller}$
Floating Supply Gate Drive		Cost impact of isolated supply is significant. Opto-coupler tends to be relatively expensive, limited in bandwidth, and noise sensitive.
Transformer Coupled Drive		Gives full gate control for an indefinite period of time, but is somewhat limited in switching performance. This can be improved with added complexity.
Charge Pump Drive		The turn-on times tend to be long for switching applications. Inefficiencies in the voltage multiplication circuit may require more than low stages of pumping.
Bootstrap Drive		Simple and inexpensive with limitations; such as, the duty cycle and on-time are both constrained by the need to refresh the bootstrap capacitor. Requires level shift, with the associated difficulties.

Fairchild Semi App Note AN-6076

UCC27712 Internal Diagram