BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

Gate Driver

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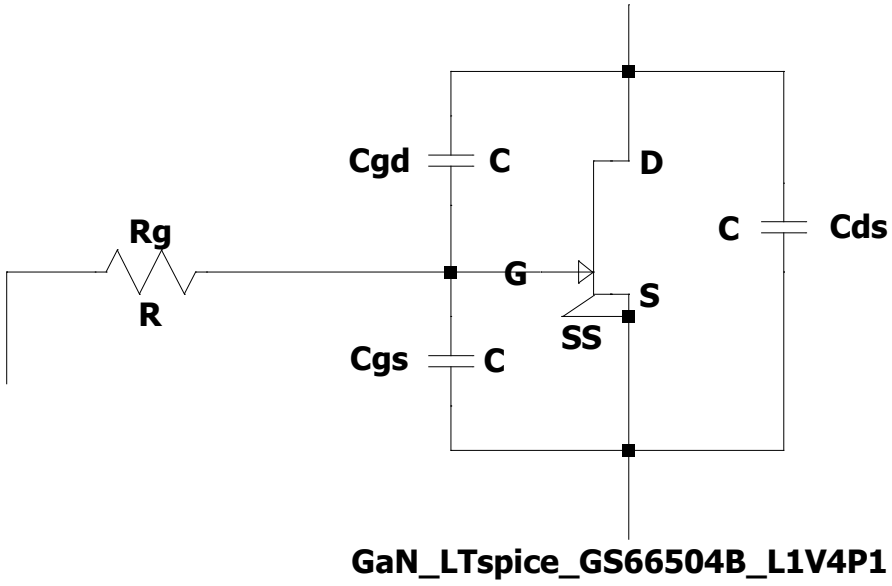
Task

Further look into why and how the gate current looks like this shape, and change the gate drive (e.g. an ideal voltage pulse source) and compare the gate curves.

Parasitic Capacitors of MOSFET:



Here,

Gate to source capacitance, C_{GS}

Gate to drain Capacitance, C_{GD} (Miller Capacitance)

Drain to source Capacitance, C_{DS}

And,

Input Capacitance, $C_{ISS} = C_{GS} + C_{GD}$

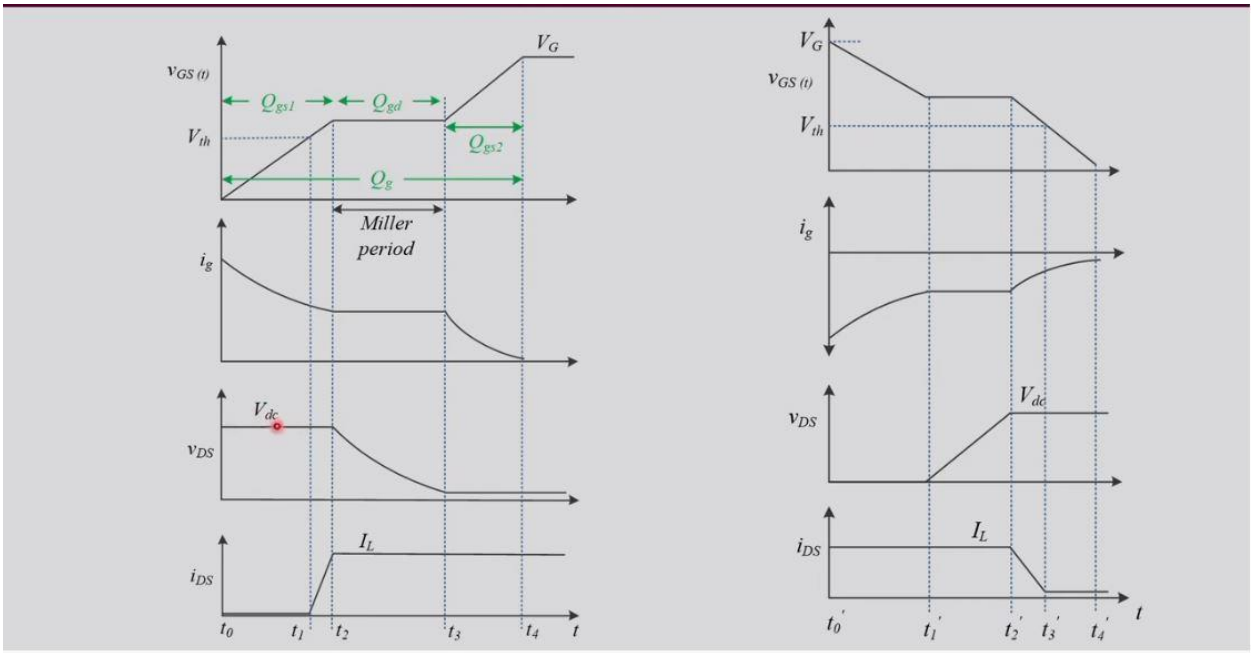
Output Capacitance, $C_{OSS} = C_{DS} + C_{GD}$

Reverse Transfer Capacitance, $C_{RSS} = C_{GD}$

"C_{GD} plays an important role to On and Off the MOSFET."

Gate Current:

From lecture video of **Prof. Shabari Nath(IIT,India)** we found,

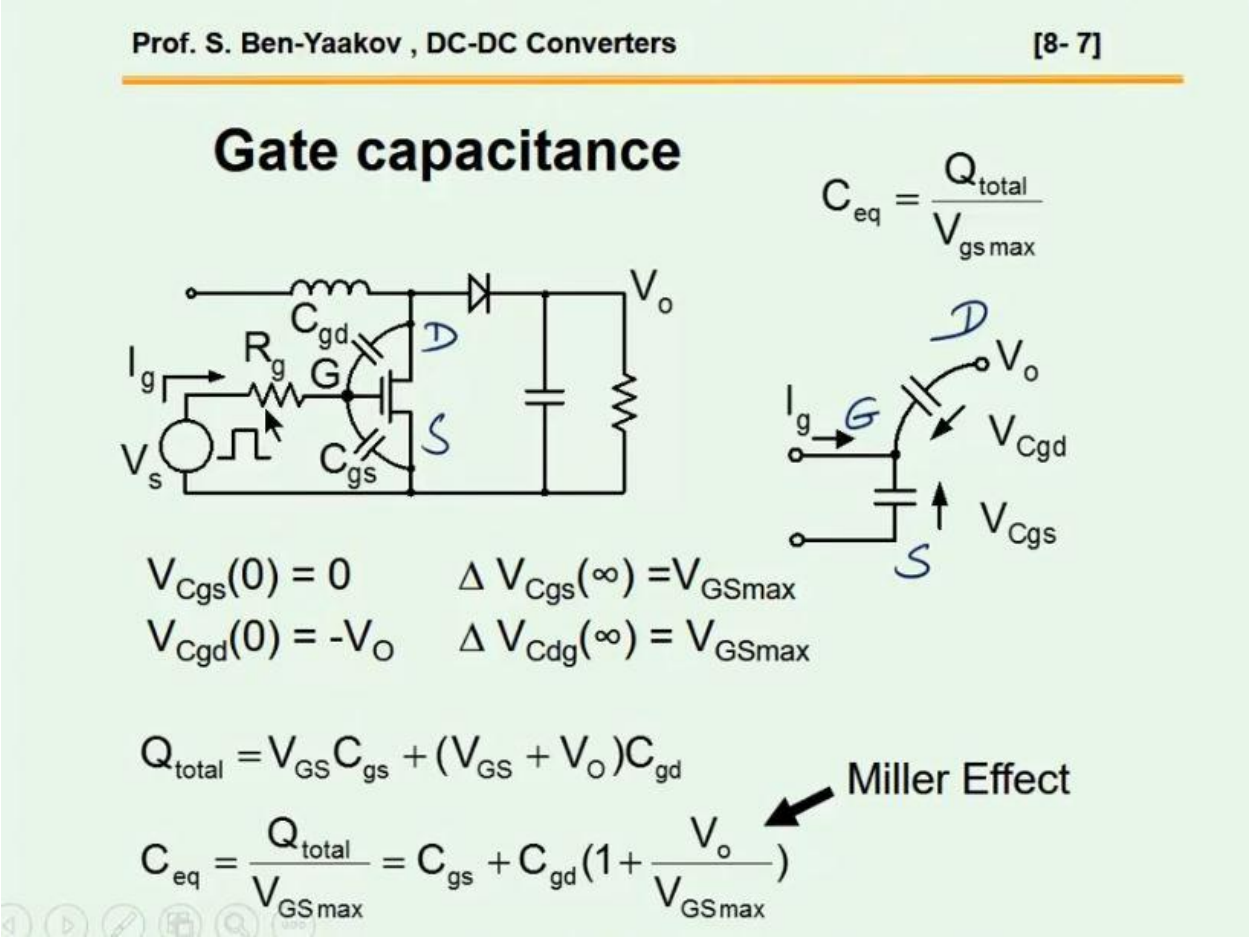


Here,

Gate current is not smooth. First it will get a peak then decrease with time. After some time current remain constant for few moments. This is caused by **"Miller Effect"**.

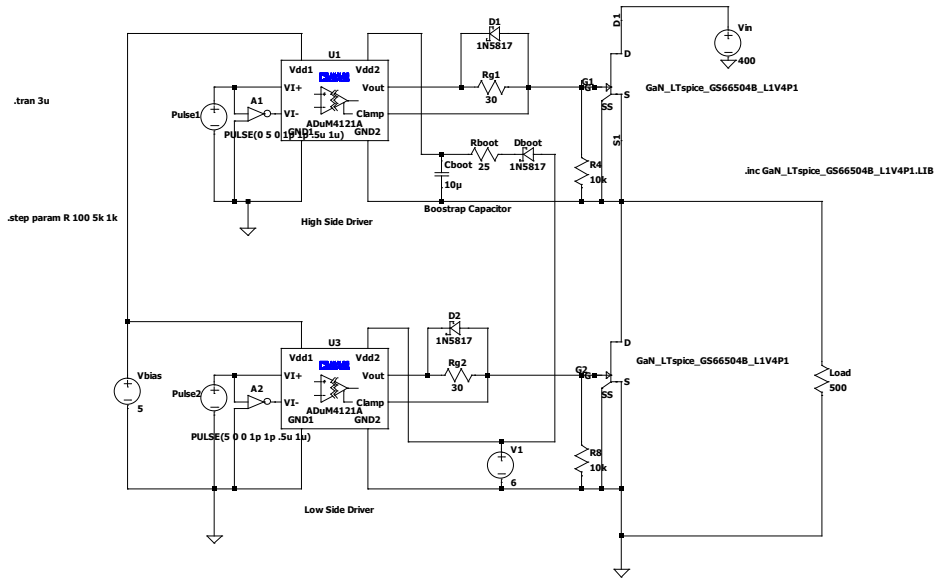
When the gate current and voltage waveshape is parallel to the time axis then it is called **"Miller Plateau"** region occurred by Miller Effect.

Here is the equation for this found from **Prof. S. Ben Yaakov's** lecture on Miller effect,

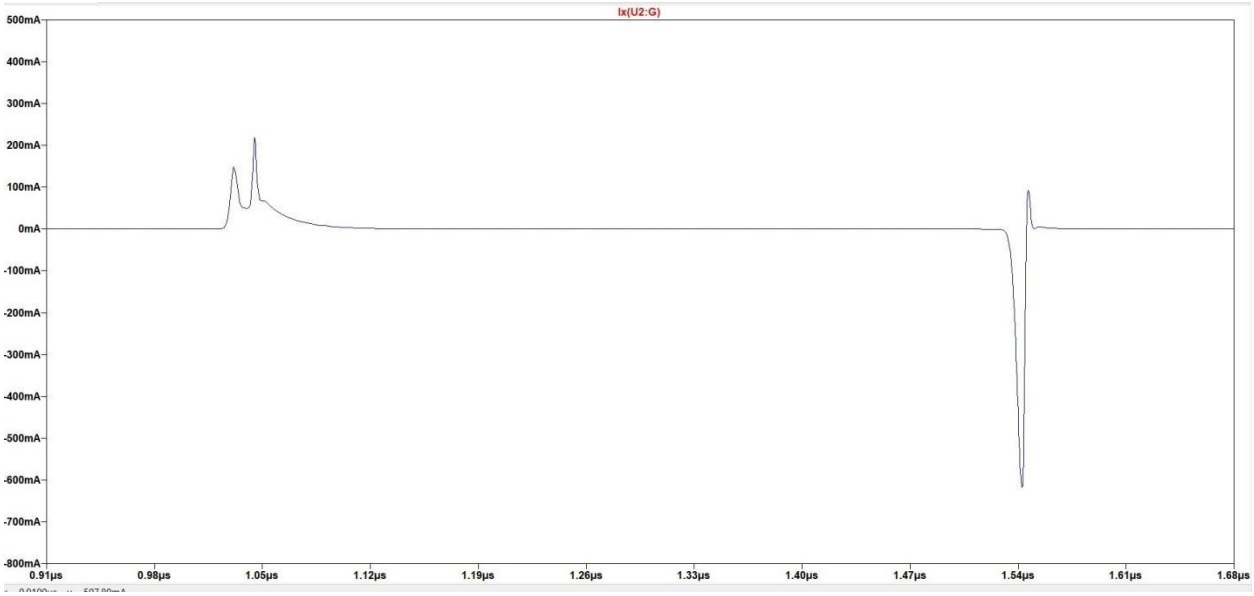


This extra $\frac{V}{Vgs}$ Cgd capacitance causes Miller effect on the waveshape.

Previous circuit(with Diode),



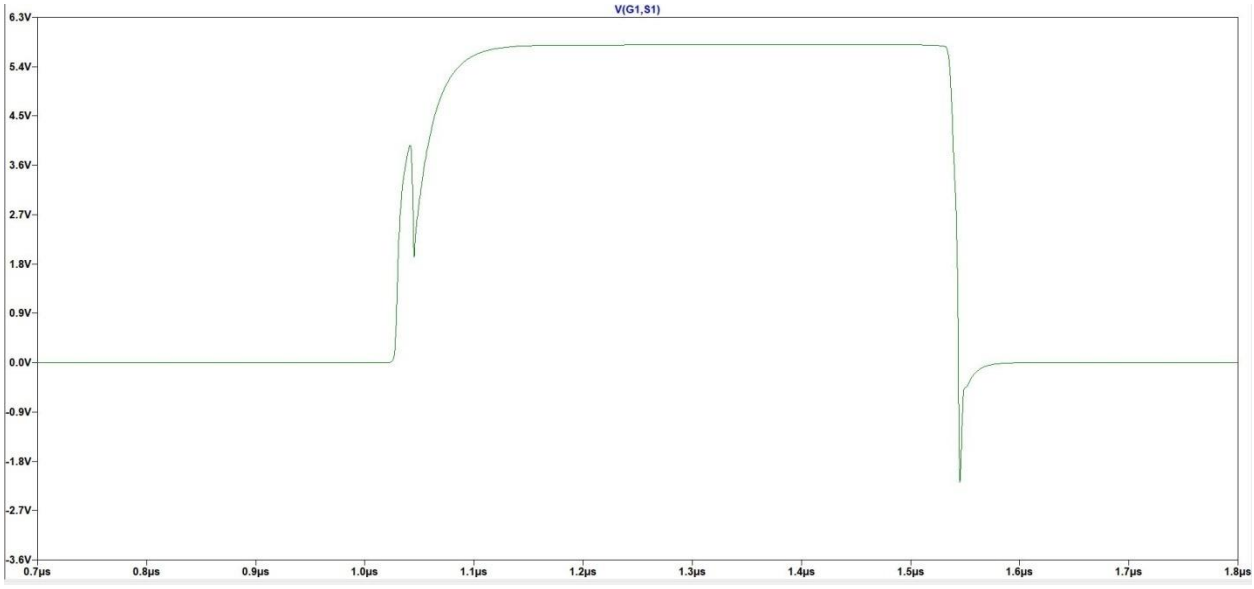
On-Off Gate Current:



During On, gate pulse “Miller Plateau” and 2 peaks.

During off, gate pulse doesn’t have a “Miller Plateau” region.

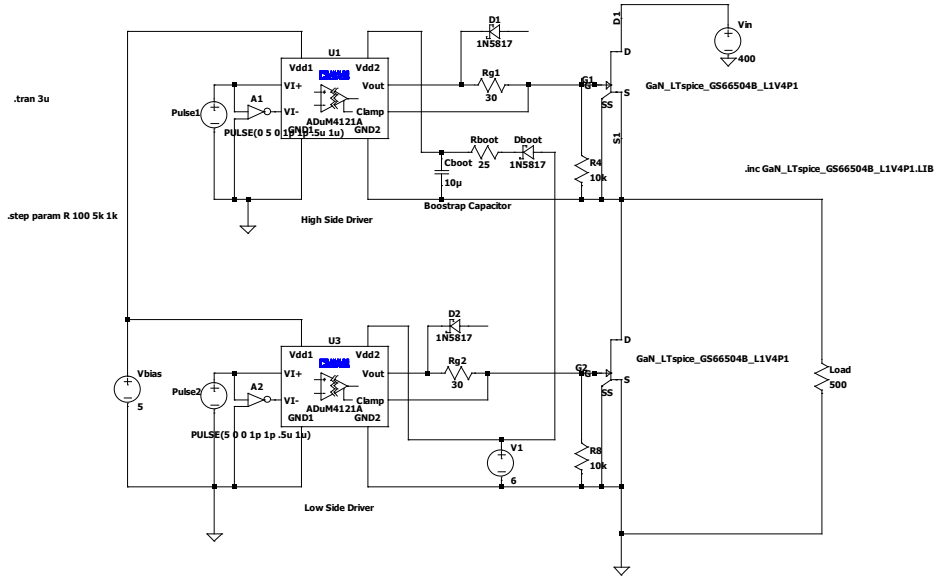
Gate to source Voltage:



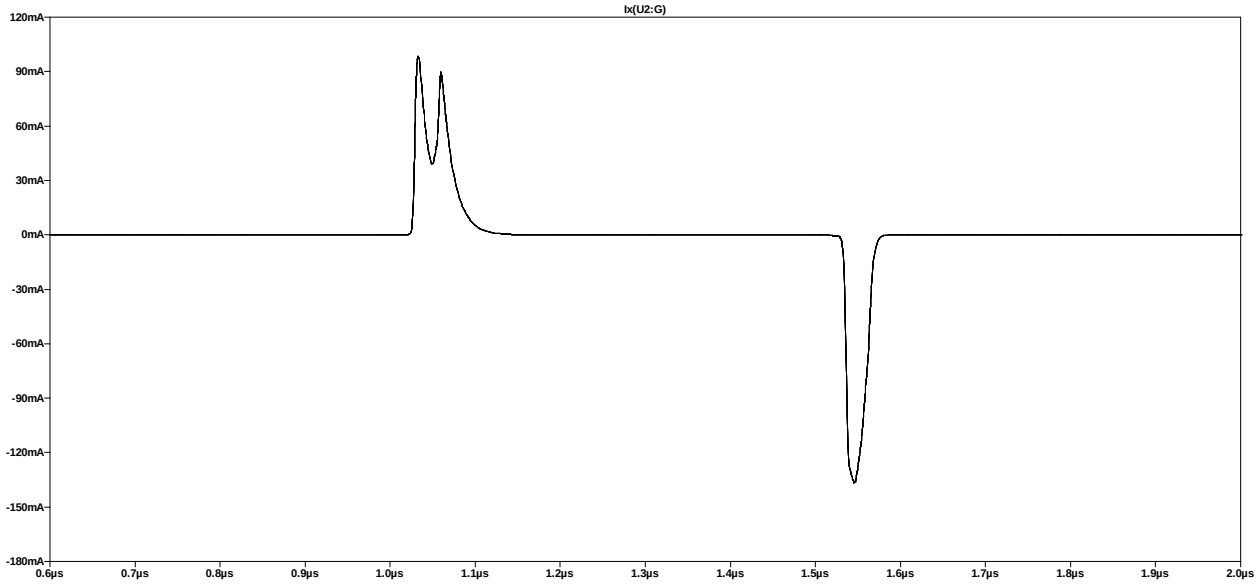
There is “Miller Plateau” during turning on, but not in turning off time rather having a negative voltage spike.

If we Disconnect diode D1 and D2, the circuit:

(*Datasheet suggest that diode part is optional)



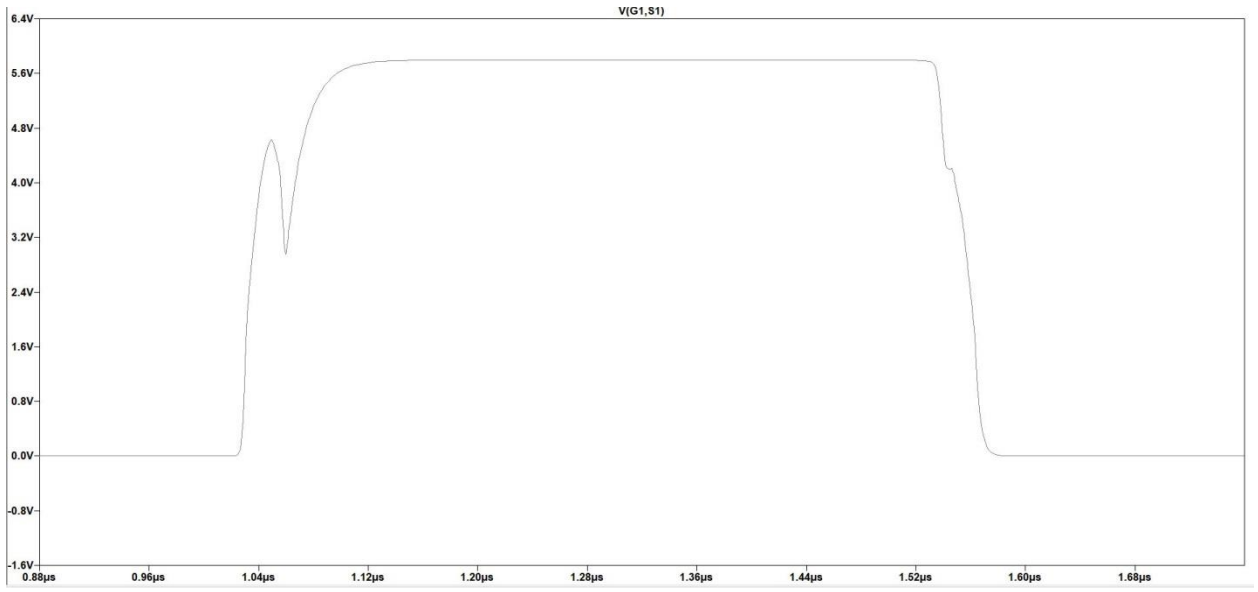
Waveshape of Gate current:



During Turn On, wavehape showing “Miller plateau”.

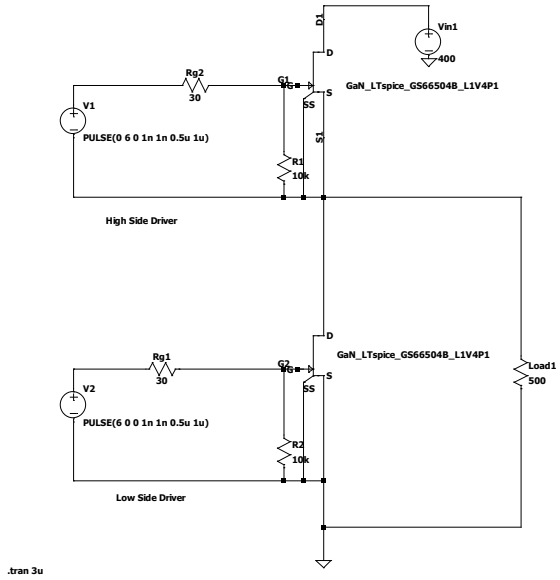
During Turn Off, again no “Miller plateau” region.

Gate to Source voltage:

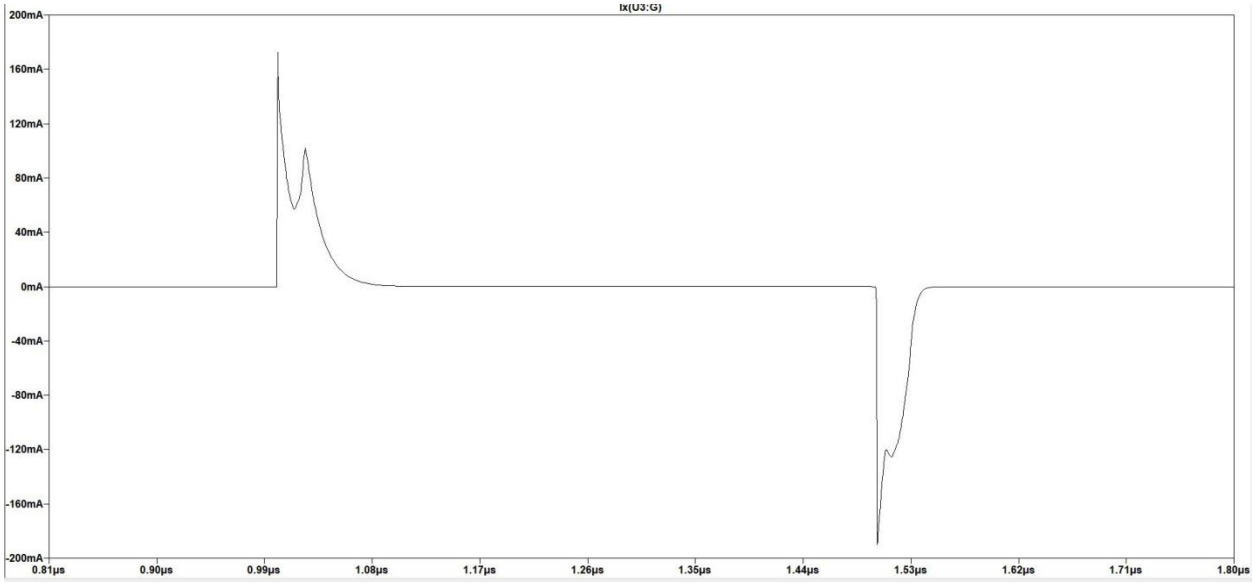


Reduction of “Miller plateau” in turning off time and no negative voltage spike.

Circuit with Voltage Pulse(without driver):



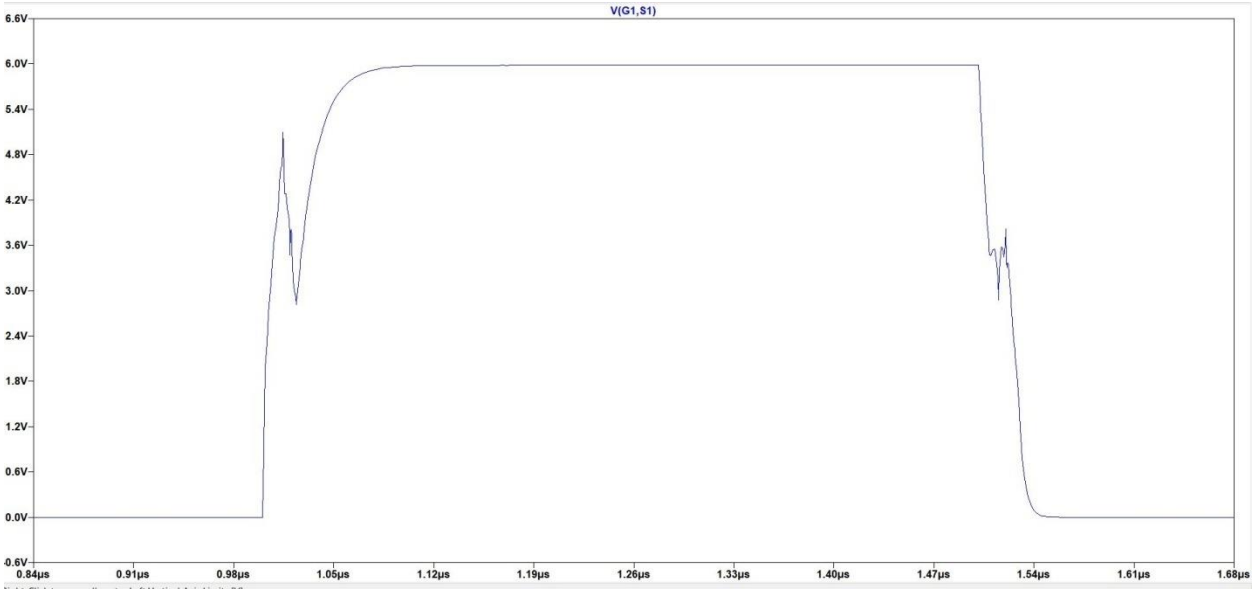
Gate Current:



Here,

During on and off both time there is expected “Miller Plateau” region.

Gate to source voltage:



Here is also found expected “Miller Plateau” region during on and off of the MOSFET.

Comparison

***With driver circuit,** there is less Miller effect. But need to choose proper R_g on/off resistor & diode for better performance.

***Without driver,** more Miller effect.