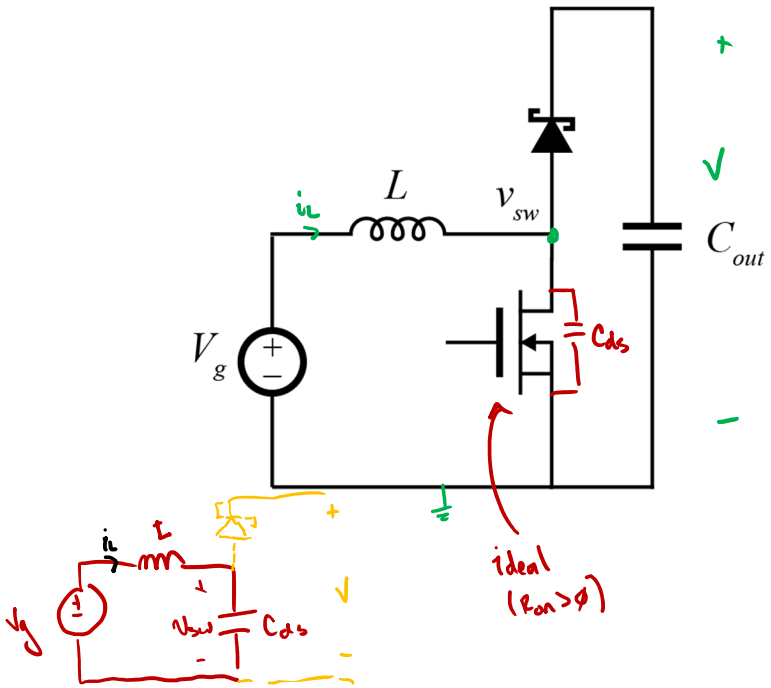
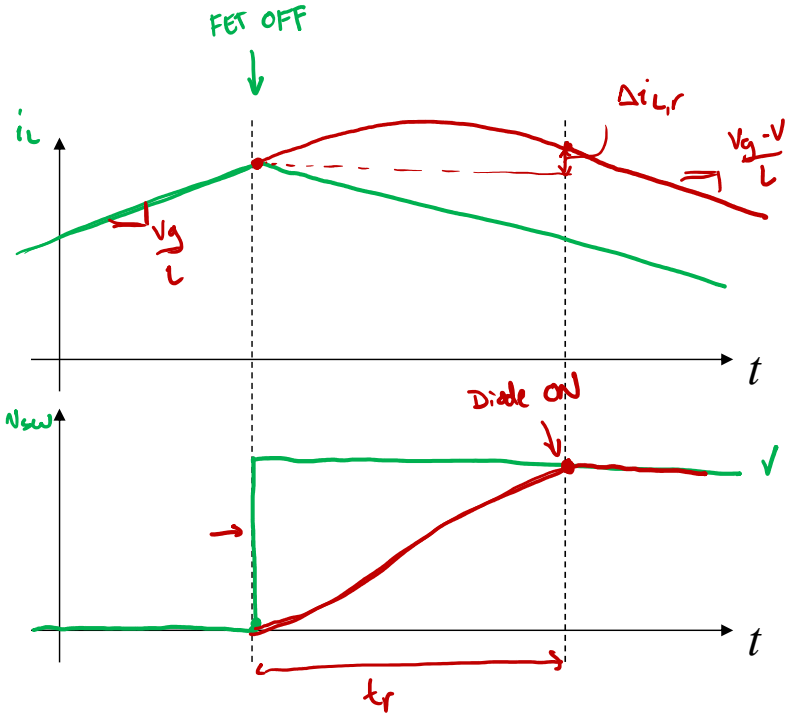
# Device Capacitances




FET Turn-off



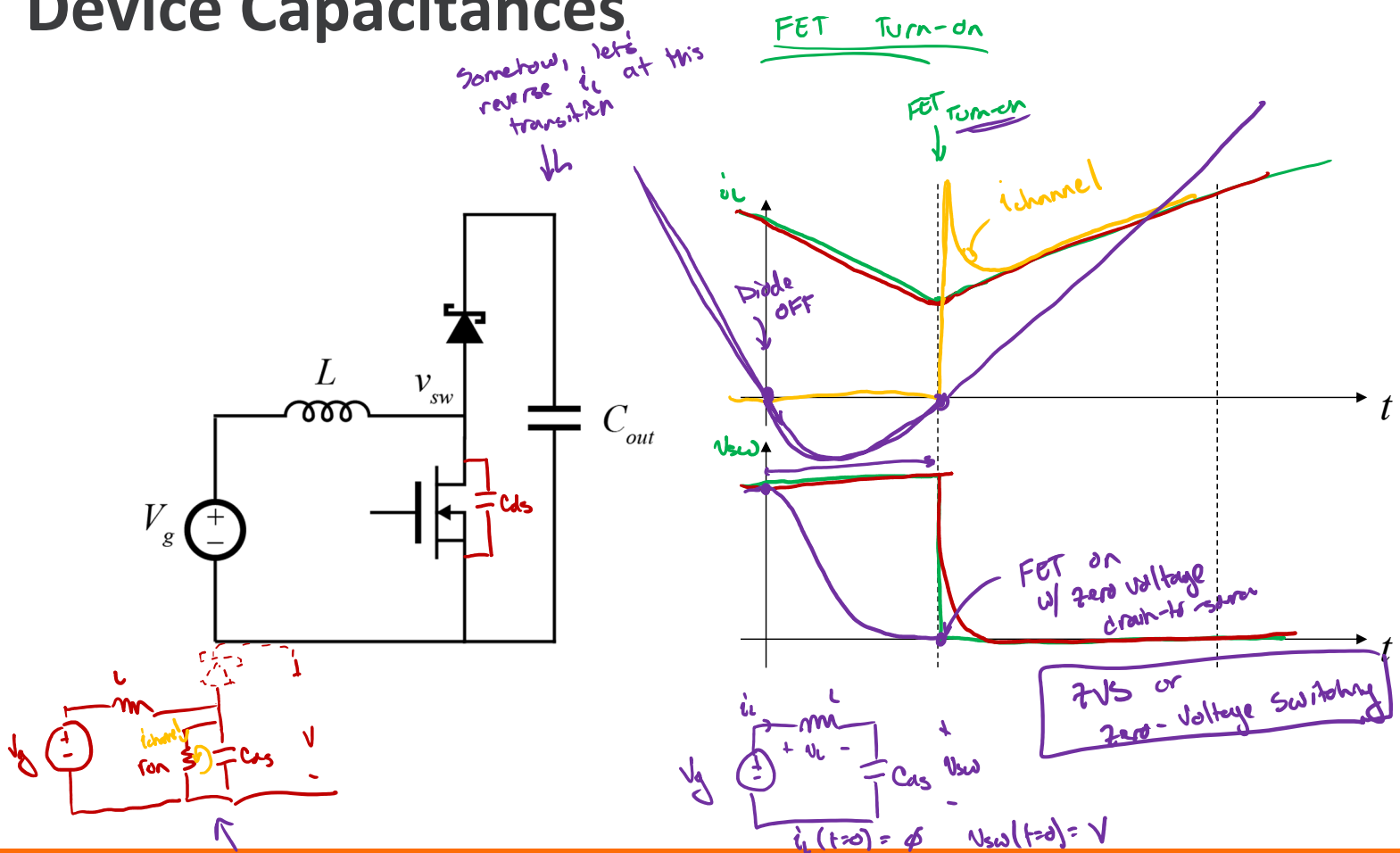

Losses: None!

4&1 approximations

$t_r \approx 0$

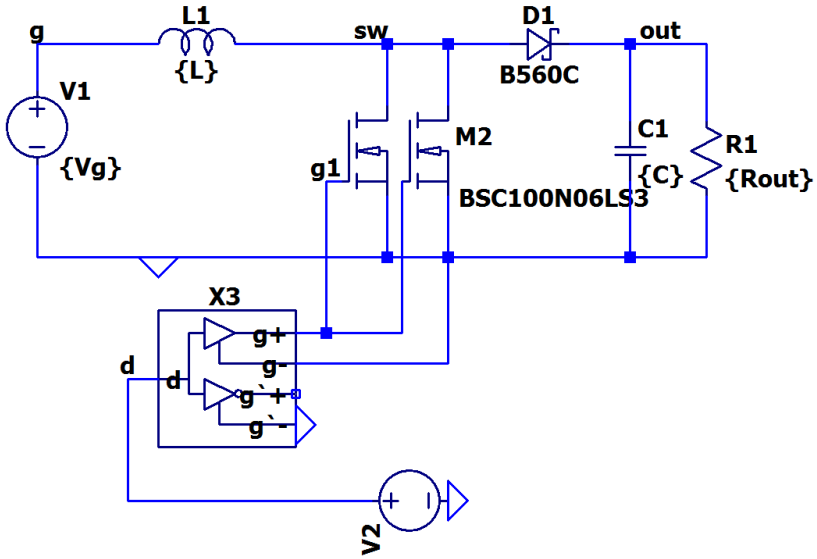
$\Delta i_{L,r} \ll I_L$

# Device Capacitances




$E_{loss}$: All of $\frac{1}{2} C_{ds} V^2$ from turn-off

# DCM: Soft Switching

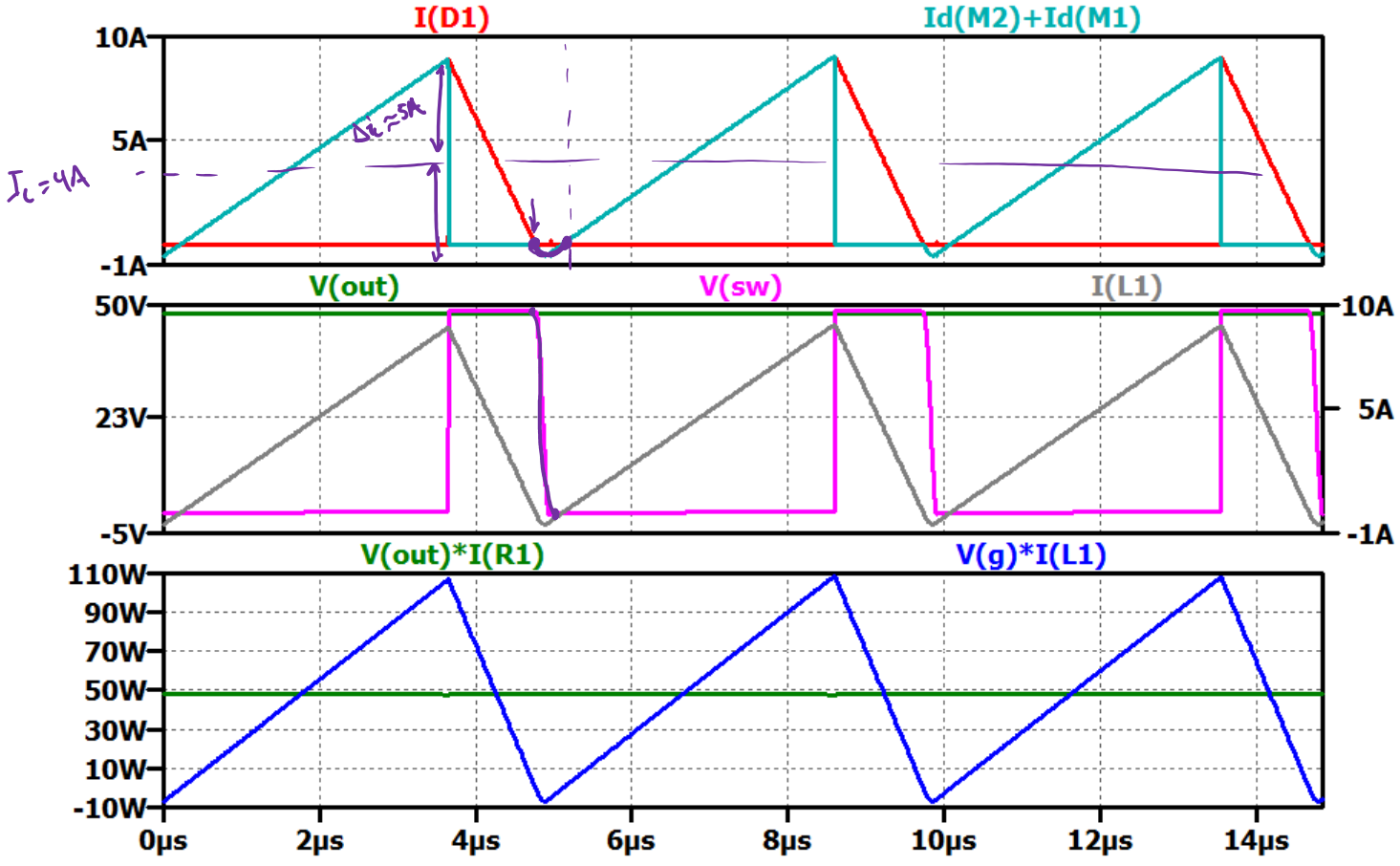



| $L$ | $C_{out}$ | $f_s$ | Diode | $\eta$ (Sim) |
|---|---|---|---|---|
| 22uH | 22uF | 202k | Si (FR) | 93.9% |
| 22uH | 22uF | 202k | Si Schottky | 95.8% |
| 4.6uH | 22uF | 202k | Si Schottky | 98.2% |

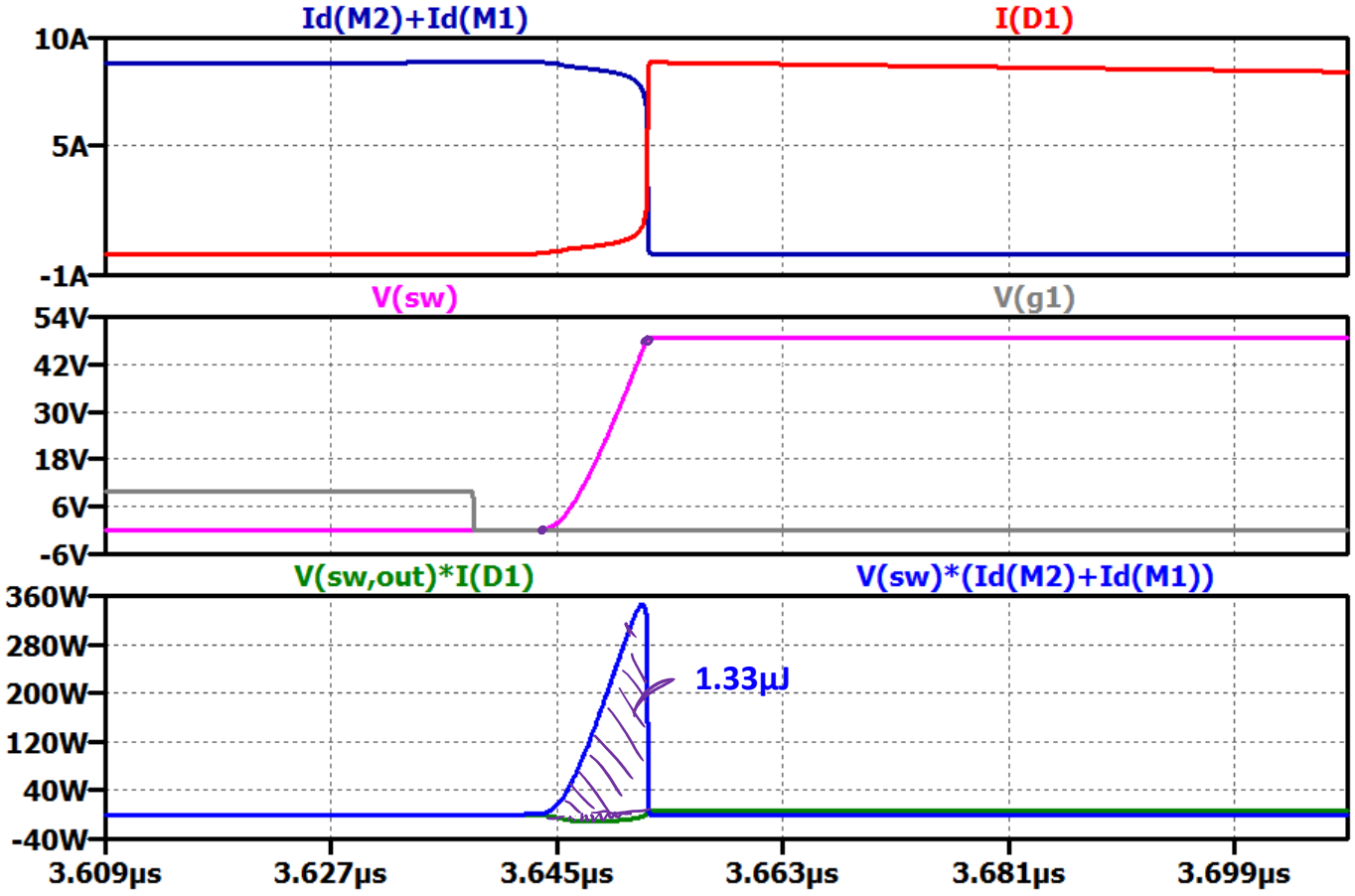
Drop L by ~5x

2.4% increase in $\eta$!

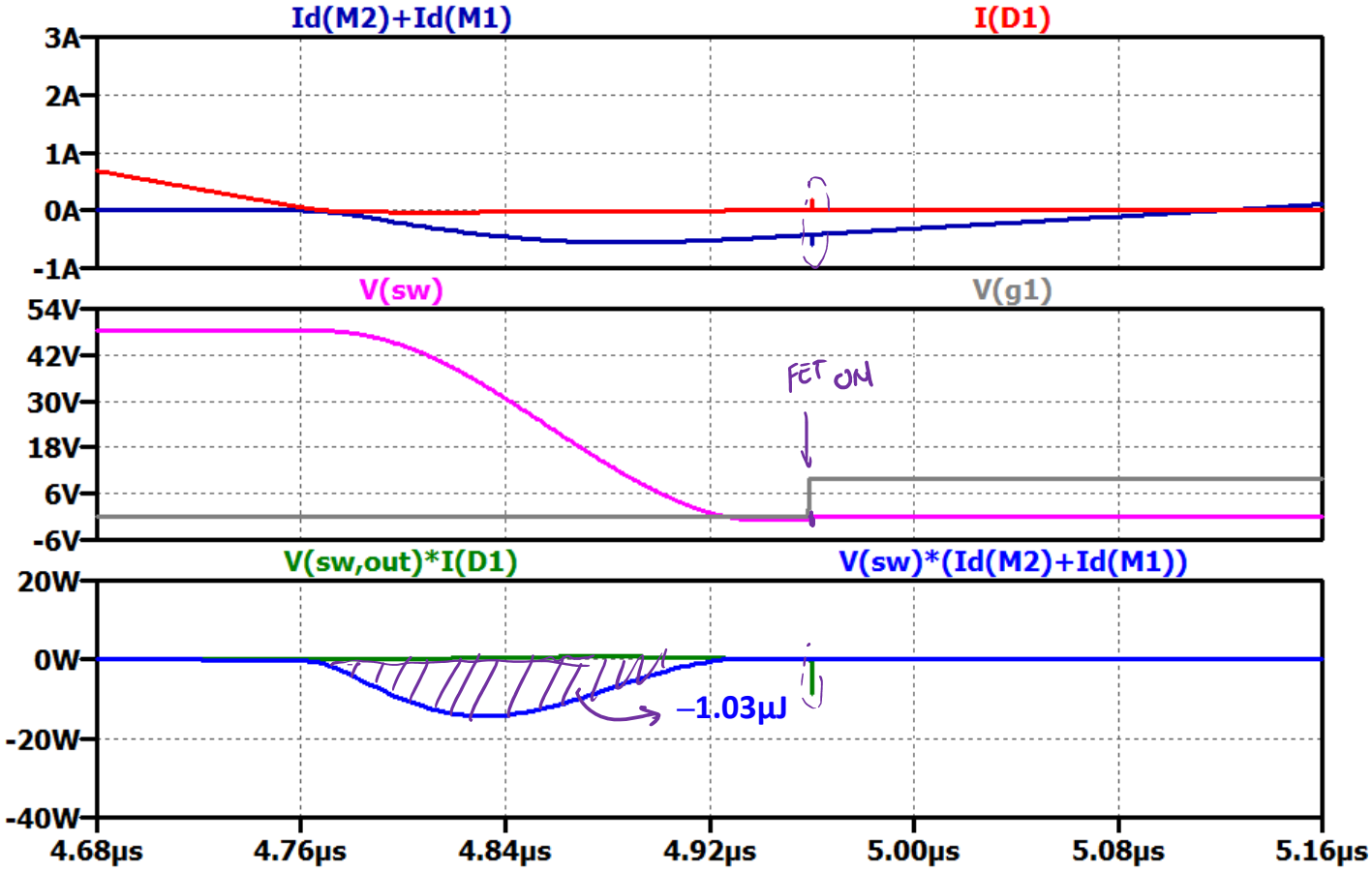
# DCM Simulation



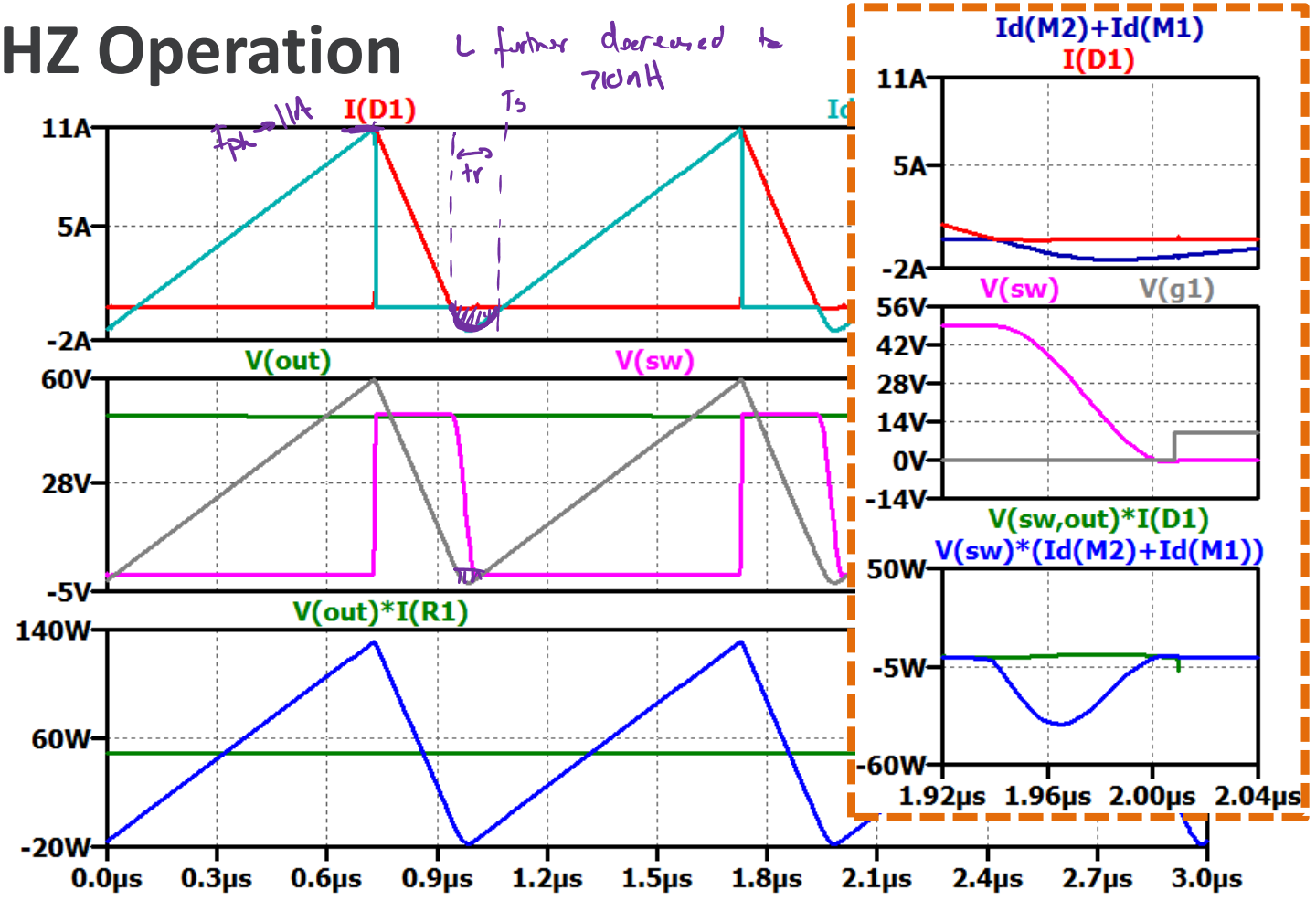
# MOSFET Turn-Off



# MOSFET Turn-On

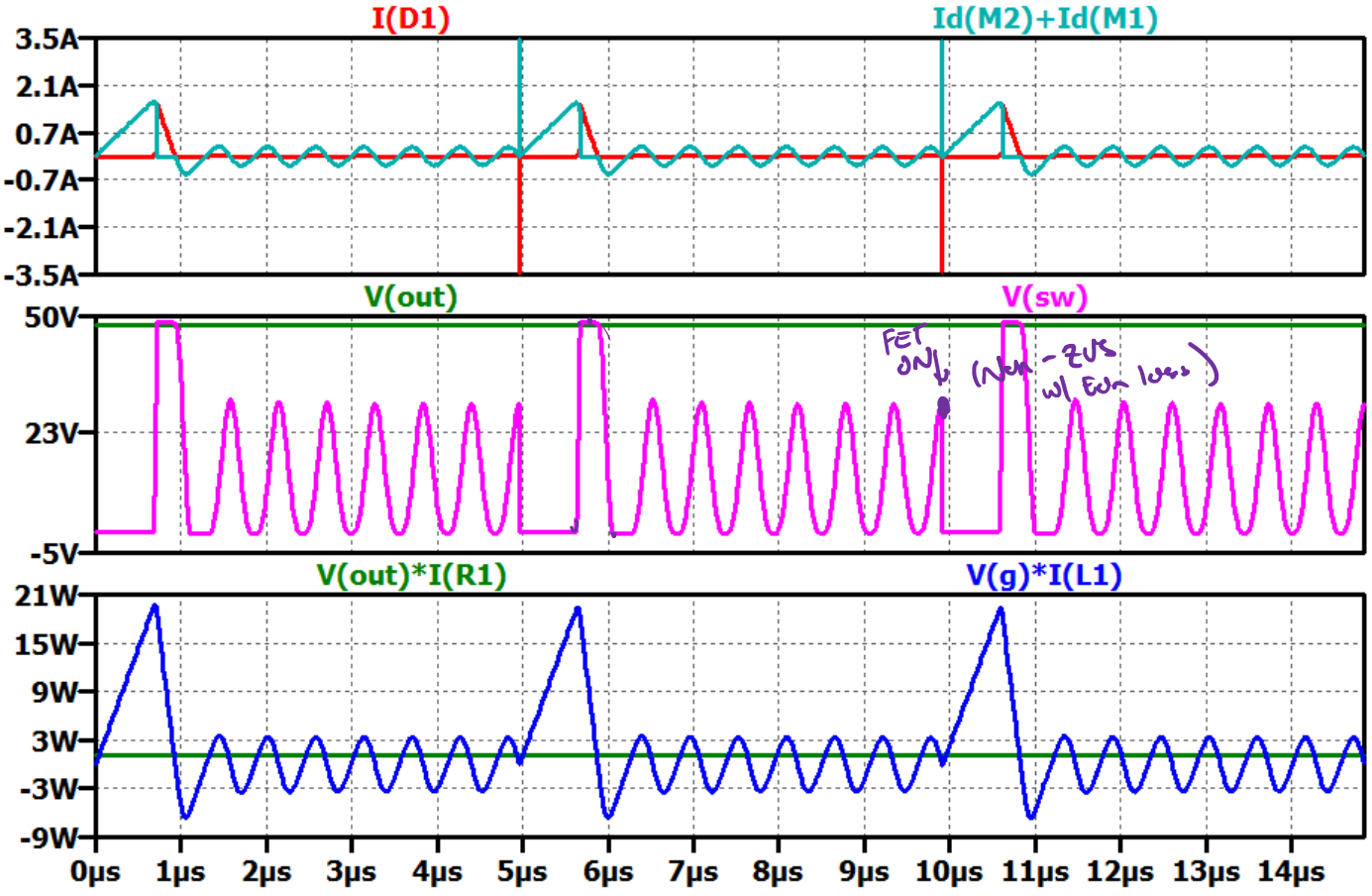


# 1 MHZ Operation

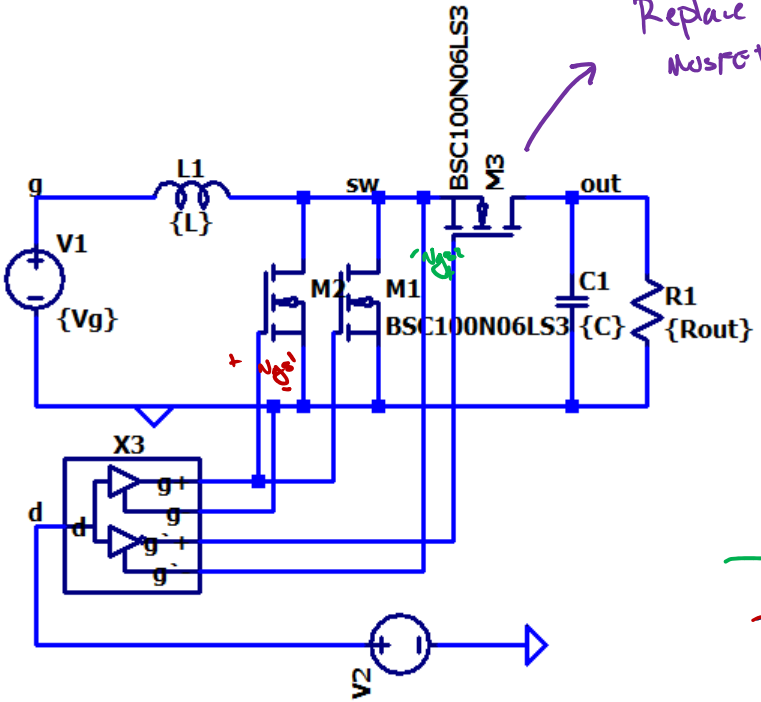


# Low Power Operation

Pout = 1W  η = 68%



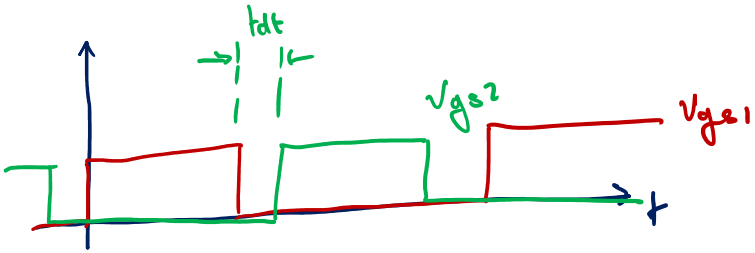
# Synchronous Operation




Replace diode w/ FET
MOSFET is current-bidirectional
+ Allows control of device turn-off instant

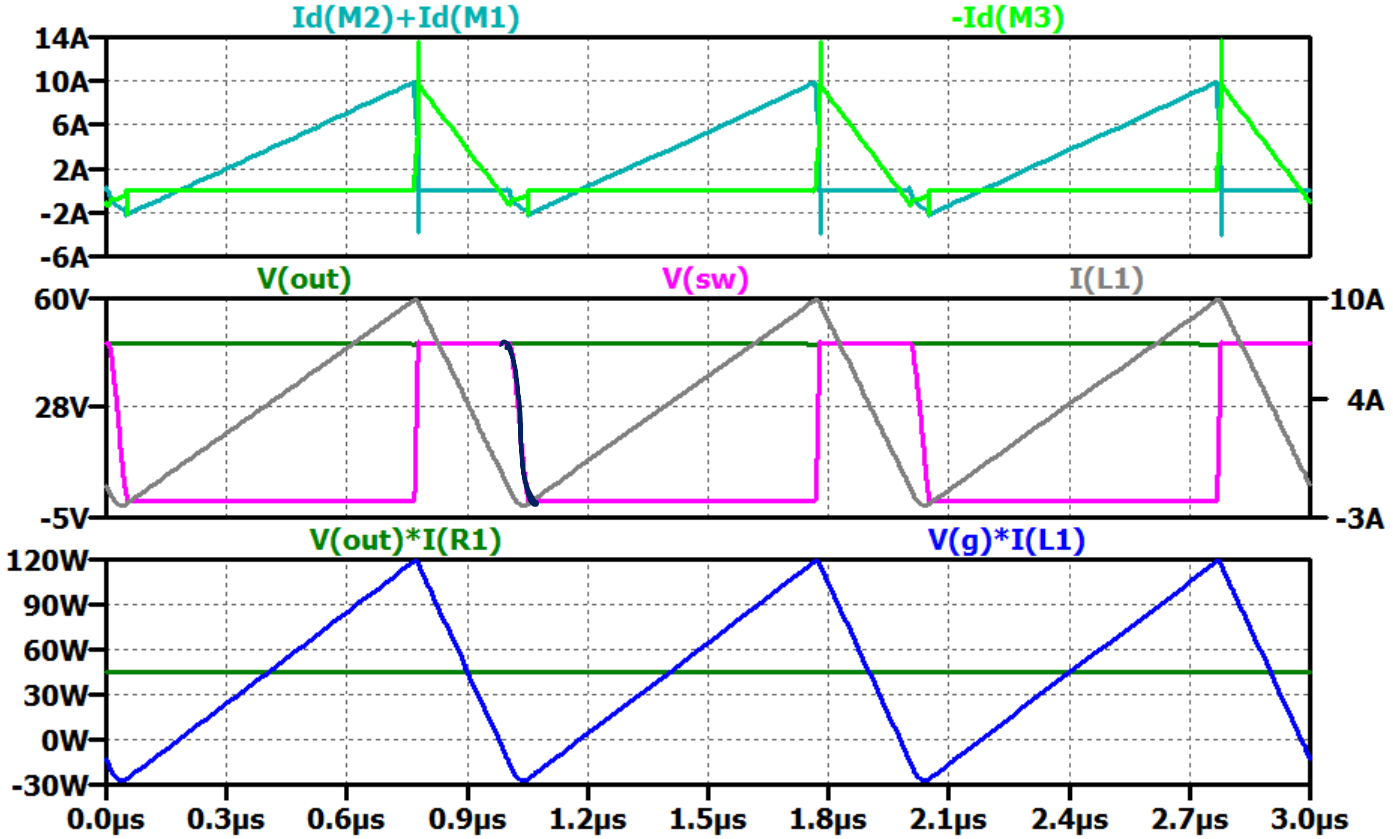
+ Replace Conduction loss $V_F I$ w/ $I^2 R_{on}$

- Need to generate two gate drive signals

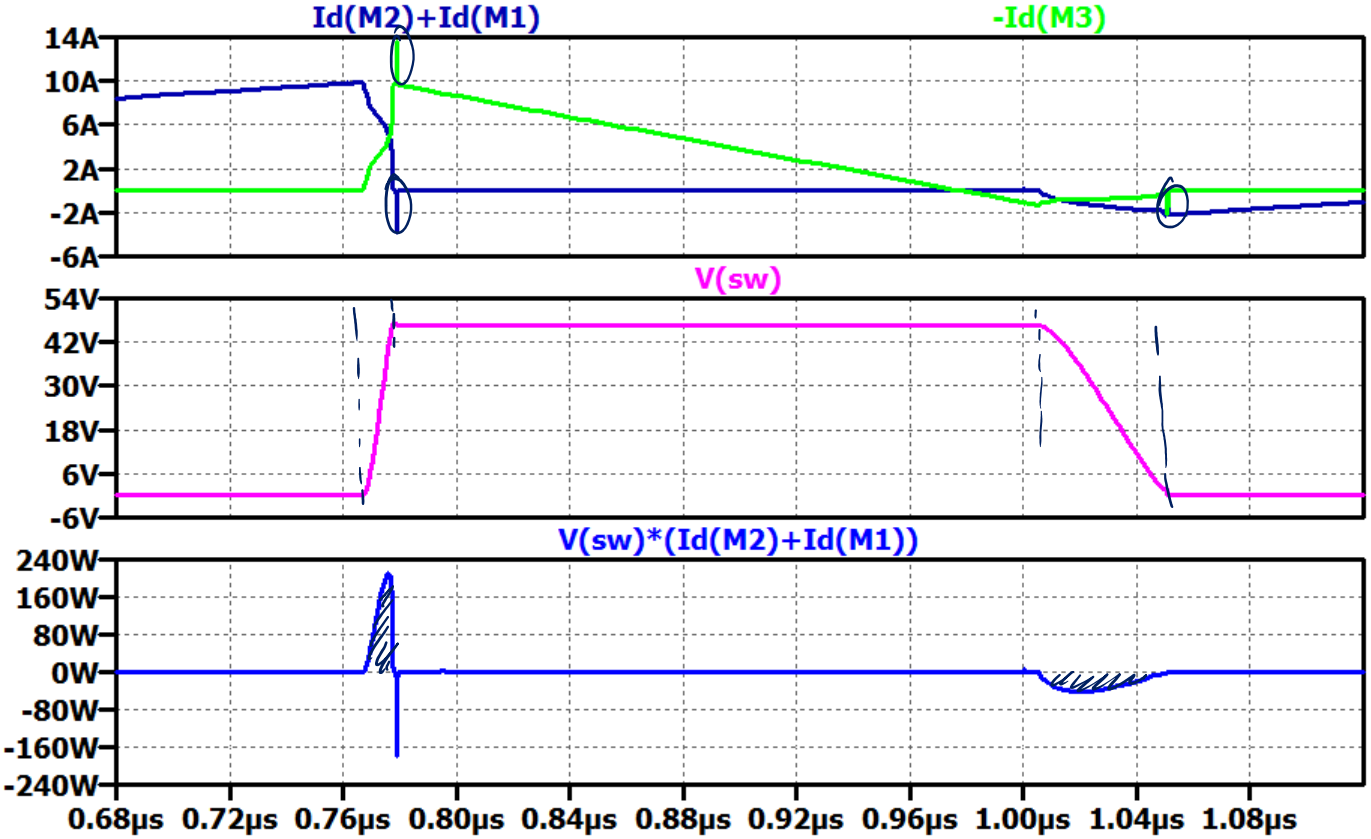


# Synchronous Simulation

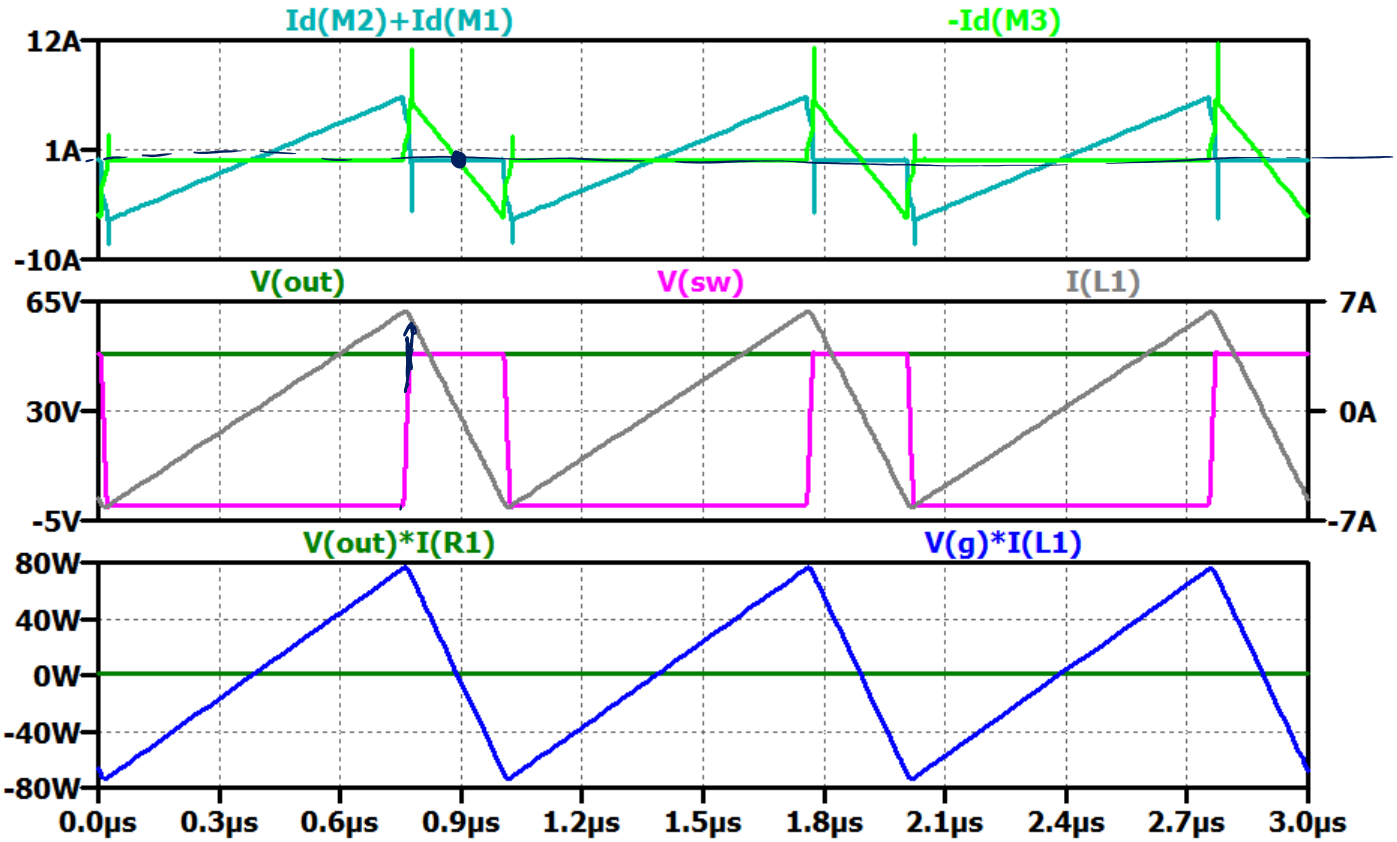
$P = 48W$ $\eta = 99.6\%$



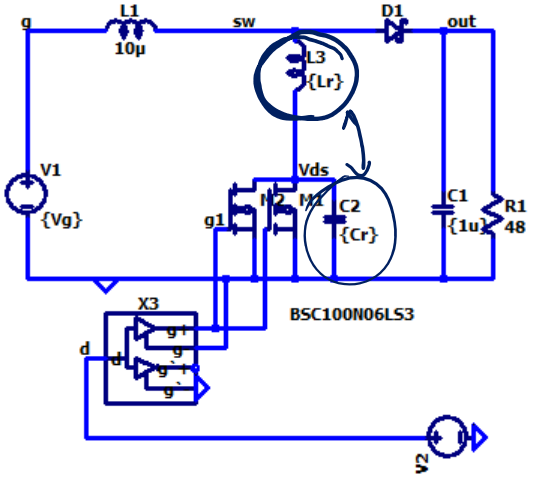
# Switching Transitions



# Low Power Operation $P_{out} = 1W$ $\eta = 91\%$



# Resonant Operation




| Switching | L | $C_{out}$ | $f_s$ | Diode | $\eta$ (Sim) |
|---|---|---|---|---|---|
| Hard | 22uH | 22uF | 202k | Si (FR) | 93.9% |
| Hard | 22uH | 22uF | 202k | Si Schottky | 95.8% |
| Soft | 4.65uH | 22uF | 202k | Si Schottky | 98.4% |
| Soft | 710nH | 4.4uF | 1 MHz | Si Schottky | 98.2% |
| Soft | 710nH | 4.4uF | 1 MHz | MOSFET | 99.6% |
| Resonant | 10uH + 2.4uH | 1uF + 10nF | 225 kHz | Si Schottky | 98.6% |
| Resonant | 10uH + 2.4uH | 1uF + 10nF | 225 kHz | MOSFET | 99.96% |

# Resonant Boost Converter