

# **EXPERIMENT 1: MOSFET Switching characteristics**

## **Name -**

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**Objective -** Study the switching characteristics and switching loss calculation of MOSFET

## **Software tool:**

MATLAB Simulink, Simscape

## **Switch used:**

Power MOSFET from Simscape Electrical

## **Parameters:**

Input voltage = 50V

MOSFET:  $R_{on} = 0.4 \text{ Ohms}$ ,  $L_{on} = 1.3e-8 \text{ H}$ ,  $V_f = 1.4V$

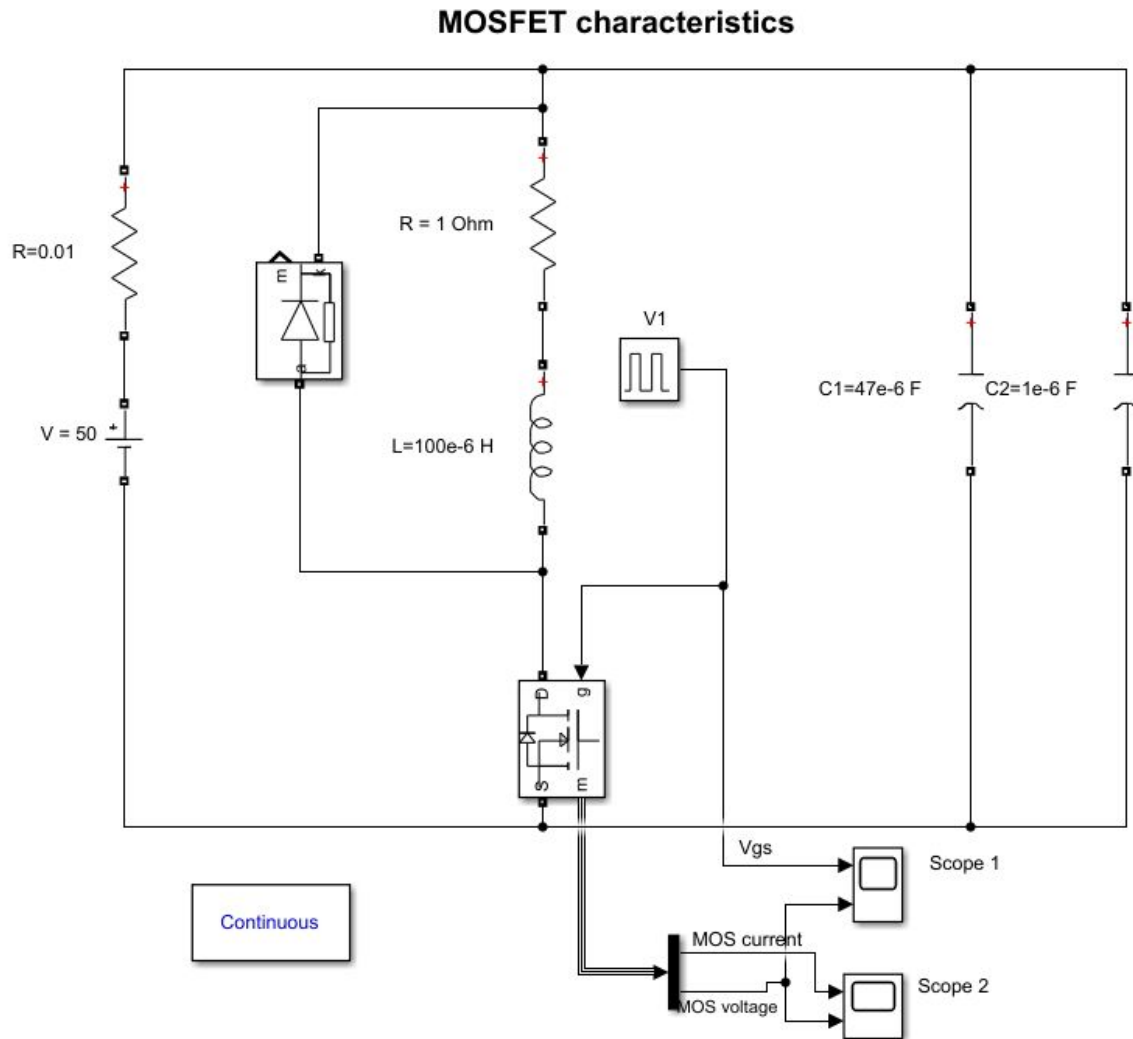
Pulse: Amplitude = 15, Period =  $5e-5$  seconds, Pulse width = 50%,

Phase delay = 0 sec

Diode, Resistance (0.01 Ohms, 1 Ohm), Inductor ( $100e-6 \text{ H}$ ),

Capacitance ( $47e-6 \text{ F}$ ,  $1e-6 \text{ F}$ )

## Diagram:



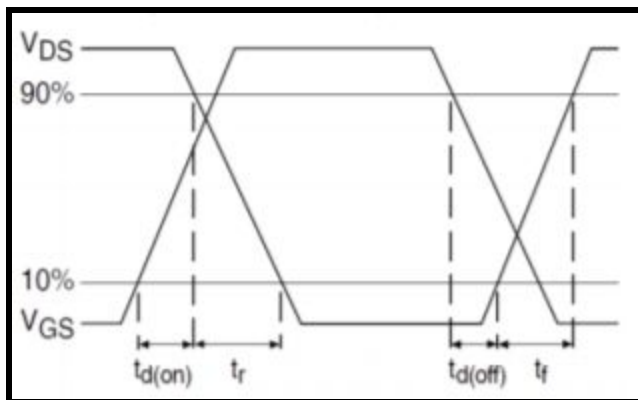
### Observations:

The model was simulated in Simulink using Simscape library

1. Observe control gate pulse waveform (VGS).
2. Observe the MOSFETs' voltage waveforms at Vds
3. Calculate the rise time and fall time.
4. Calculate the switching power loss occurring at rise time and fall time for MOSFET.

### Calculations:

Switching loss P<sub>sw</sub> can be calculated using the following formula.



Turn on losses:

$$P_{SW,turn-on} = \frac{1}{2} V_{SW,turn-on} * I_{SW,turn-on} * f_s * (t_r + t_{d(on)})$$

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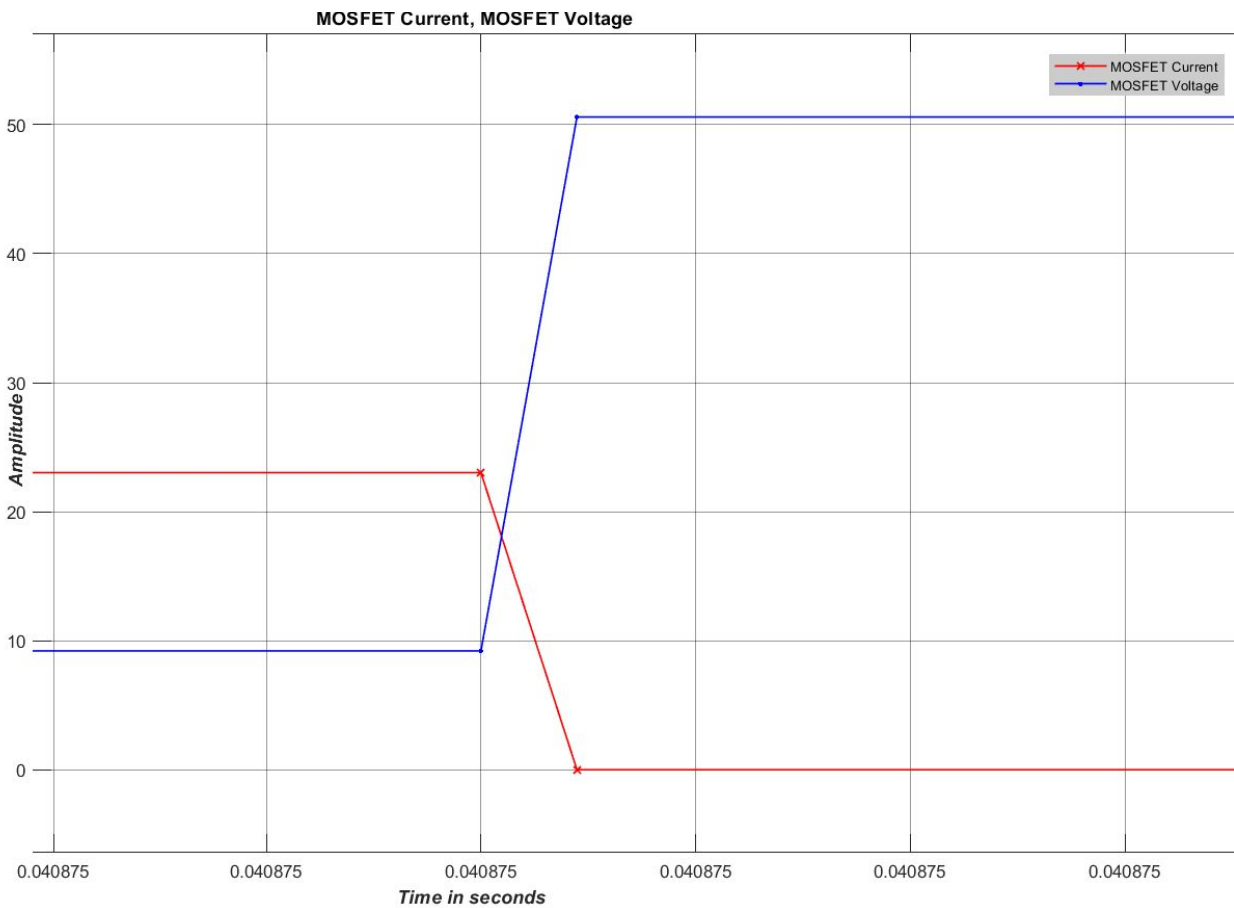
$$P_{SW,turn-off} = \frac{1}{2} V_{SW,turn-off} * I_{SW,turn-off} * f_s * (t_f + t_{d(off)})$$

Where,  $V_{sw,turn-off}$  and  $I_{sw,turn-off}$  is turn-off transition voltage and current of switch.  $f_s$  is the switching frequency and  $t_r$  and  $t_f$  is the rise and fall time of MOSFET. Total Losses obtained as:

$$P_{SW,total} = P_{SW,turn-on} + P_{SW,turn-off}$$

## Graphs:

### 1. MOSFET Current, Voltage vs time



## 2. MOSFET Voltage, $V_{gs}$ vs time

