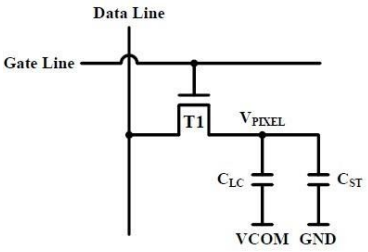
HW2 TFT LCD Simulation

1. Pixel operation

1-1 Pixel operation



Simulated parameter:

C_{LC} = 0.3 pF

C_{ST} = 0.3 pF

M_{T1} = 10

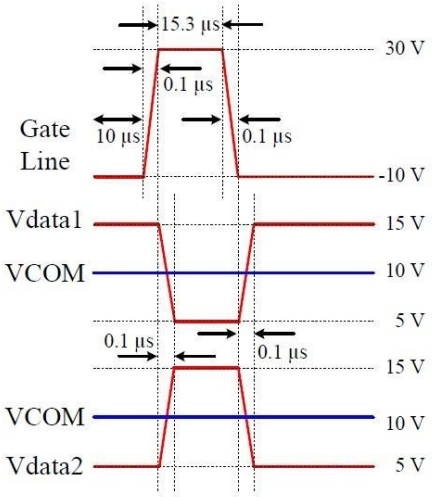
VCOM = 10 V

For Vdata1

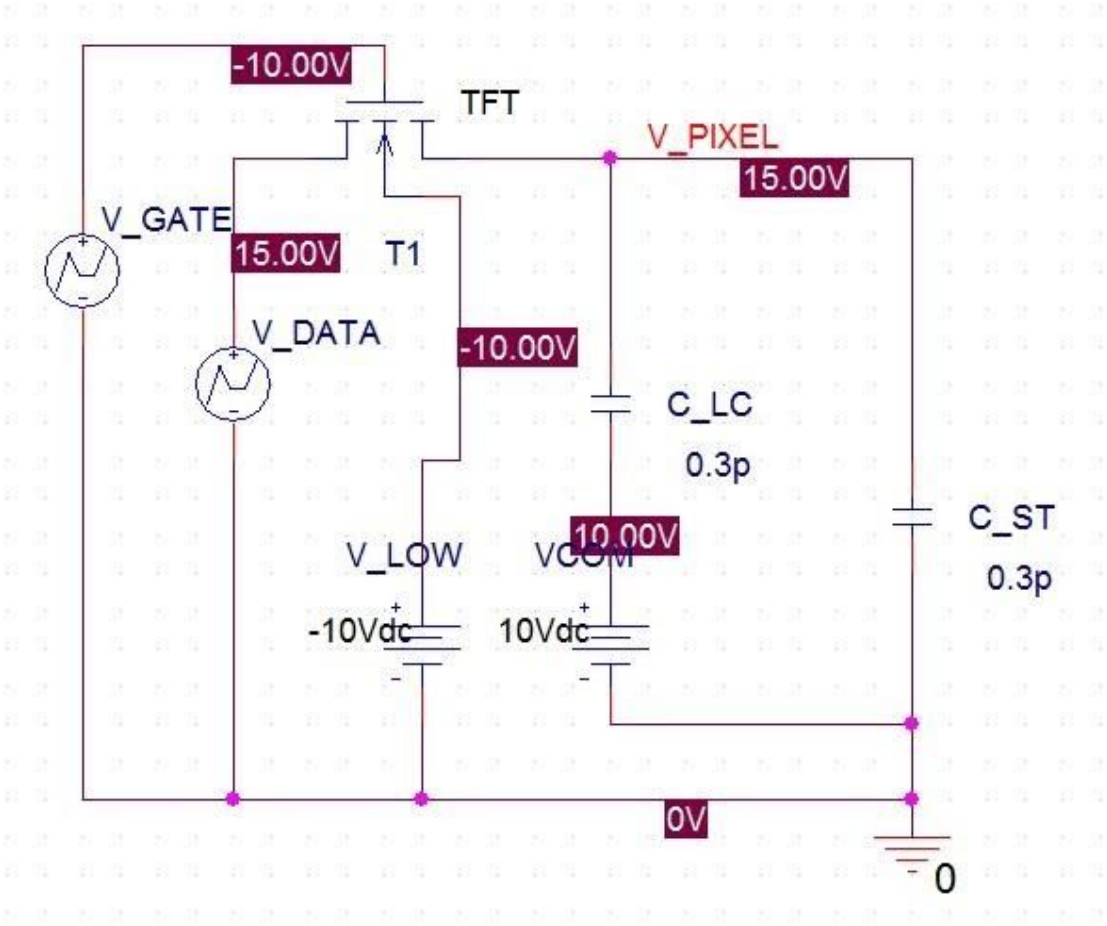
Initial V_{PIXEL} = 15 V

For Vdata2

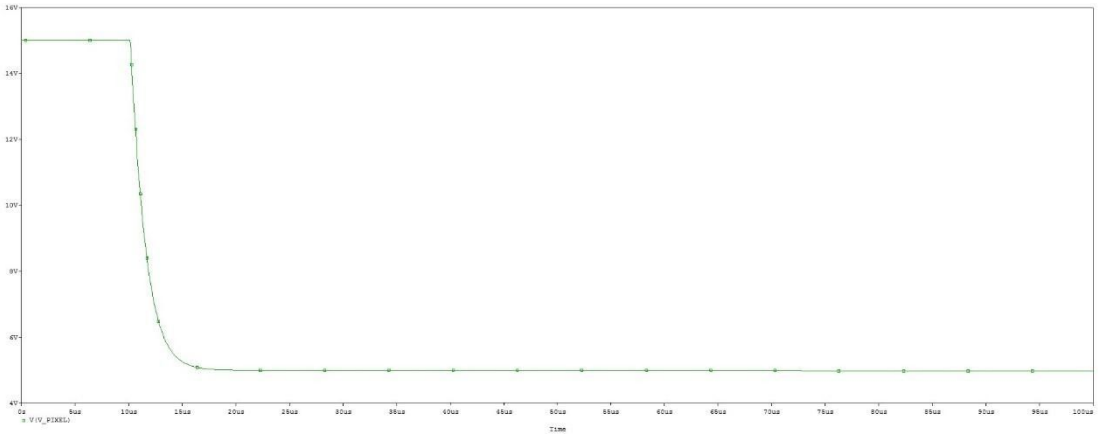
Initial V_{PIXEL} = 5 V



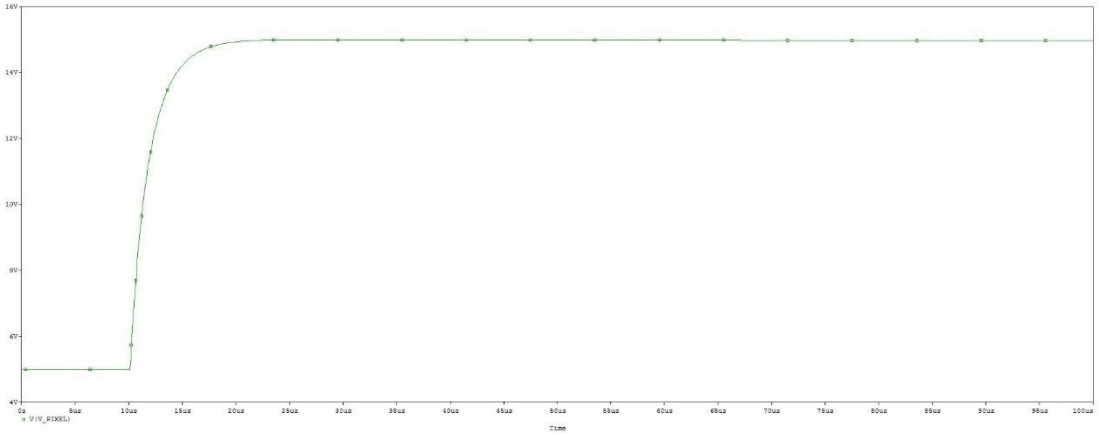
- Please simulate the pixel operation by PSPICE
- Perform two conditions, the first is negative polarity and the second is positive polarity



Please simulate the pixel operation by PSPICE
Negative polarity:



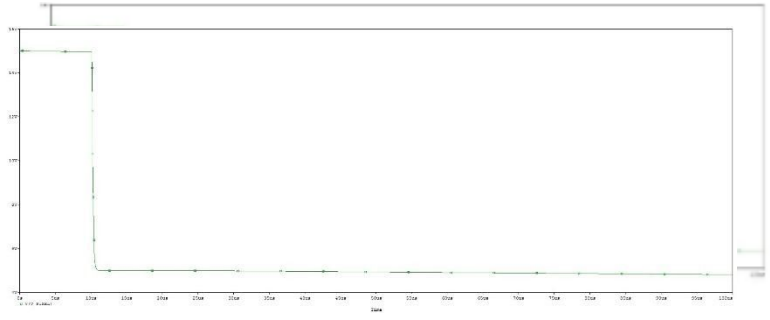
Positive polarity:

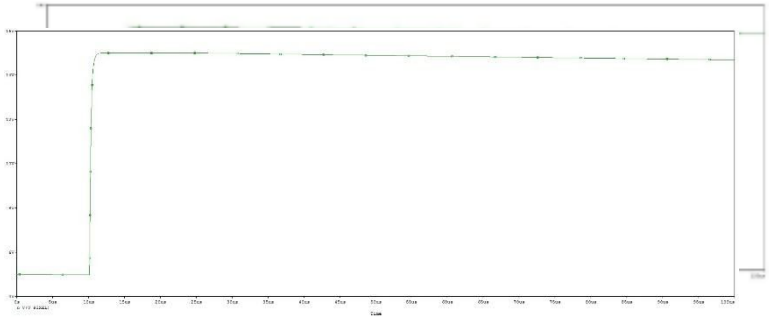


I. Set two different sizes of the switch TFT and observe the waveform of VPIXEL, describe what you see and why.

When M=100

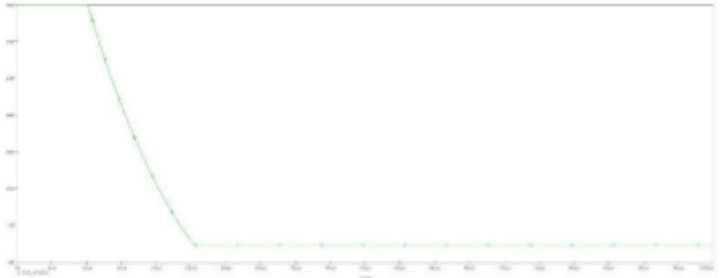
Negative polarity: Positive polarity:

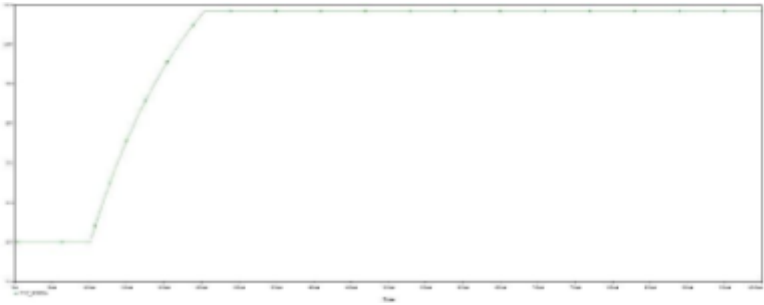




When M=1

Negative polarity: Positive polarity:





Ans:

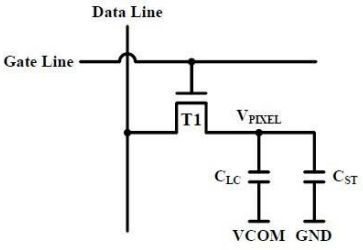
兩次實驗(negative, positive)液晶極性反轉，但傾斜角度相同；從上圖推得M增加，並聯TFT增加，造成W增加且驅動力增加，電容充放電時間減少。

II. According to the pulse width of gate line, please answer the display resolution in this practice.

Ans:
掃描一次1/60 s，且每次掃描n row，由題目可知每個row需要15.3us(pulse width of gate line)，可知1/60*1/n=15.3u得n = 1089.3246
查表得resolution 為1920*1080。

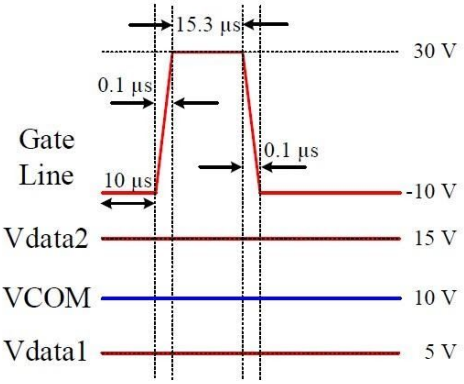
2. Pixel operation

1-2 Pixel operation

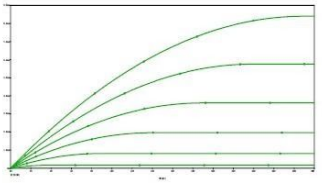


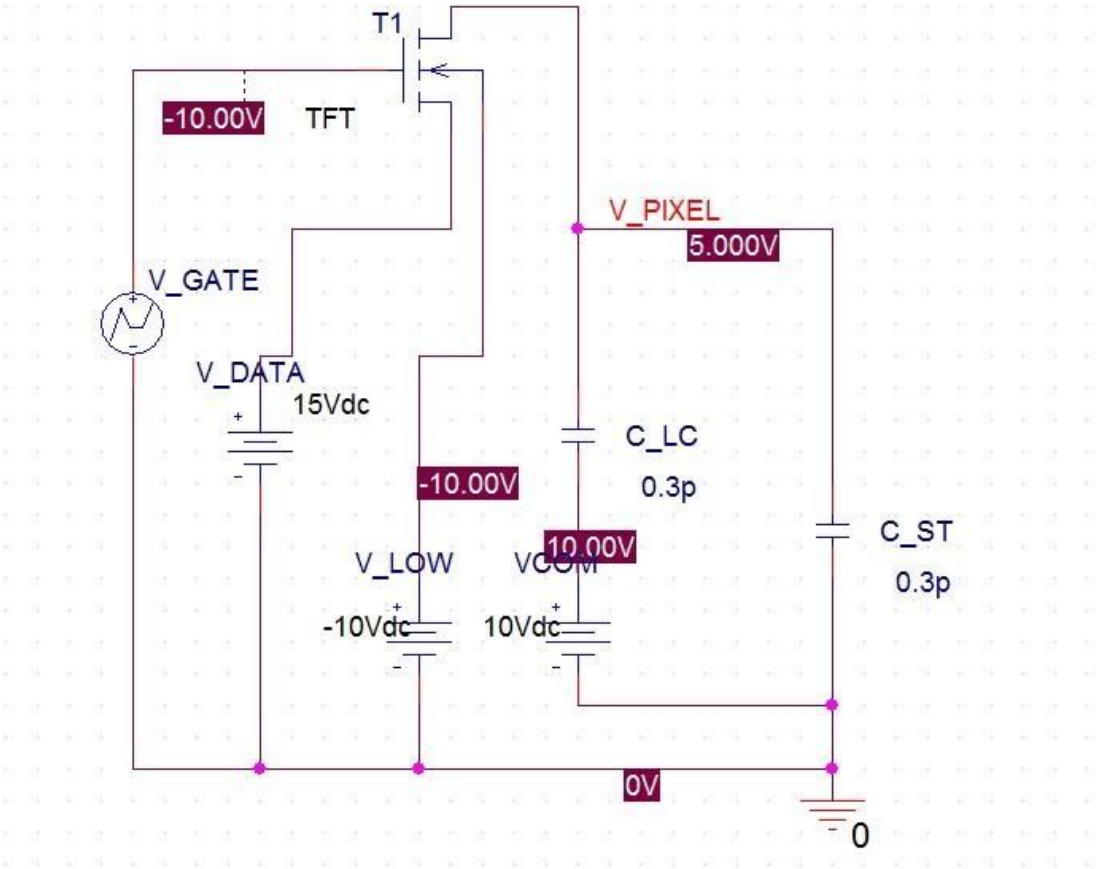
Simulated parameter:
C_{LC} = 0.3 pF
C_{ST} = 0.3 pF
M_{T1} = 10
VCOM = 10 V

For Vdata1
Initial V_{PIXEL} = 15 V
For Vdata2
Initial V_{PIXEL} = 5 V



➢ Plot the operation point curve of T1 on the output characteristics, and try to explain operation condition of T1 by this curve.





Plot the operation point curve of T1 on the output characteristics, and try to explain operation condition of T1 by this curve.

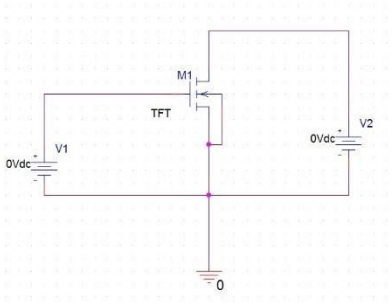
Ans:

綠色為TFT輸出特性曲線，由公式

$$V_{gs}-V_{th}\geq V_{ds} \Rightarrow I_{ds}=\mu_{eff}C_{ins}(\frac{W}{L})(\frac{V_{gs}}{V_{th}})V_{ds}=\mu_{eff}(\frac{\varepsilon_{ins}\varepsilon_{o}}{t_{ins}})(\frac{W}{L})(\frac{V_{gs}}{V_{th}})V_{ds}$$

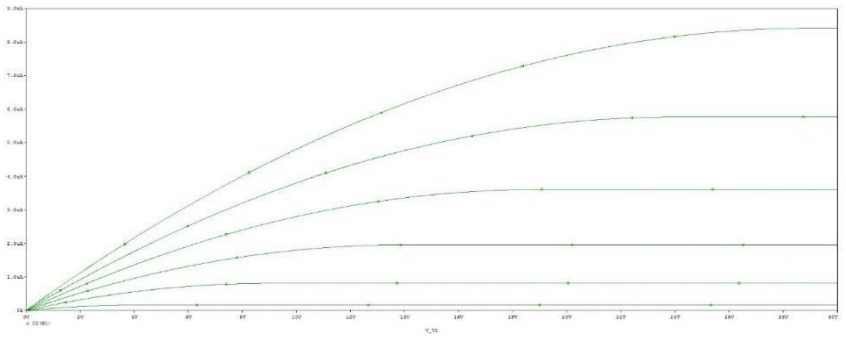
$$V_{gs}-V_{th}<V_{ds} \Rightarrow I_{ds}=\frac{1}{2}\mu_{eff}C_{ins}(\frac{W}{L})(\frac{V_{gs}}{V_{th}})^2=\frac{1}{2}\mu_{eff}(\frac{\varepsilon_{ins}\varepsilon_{o}}{t_{ins}})(\frac{W}{L})(\frac{V_{gs}}{V_{th}})^2$$

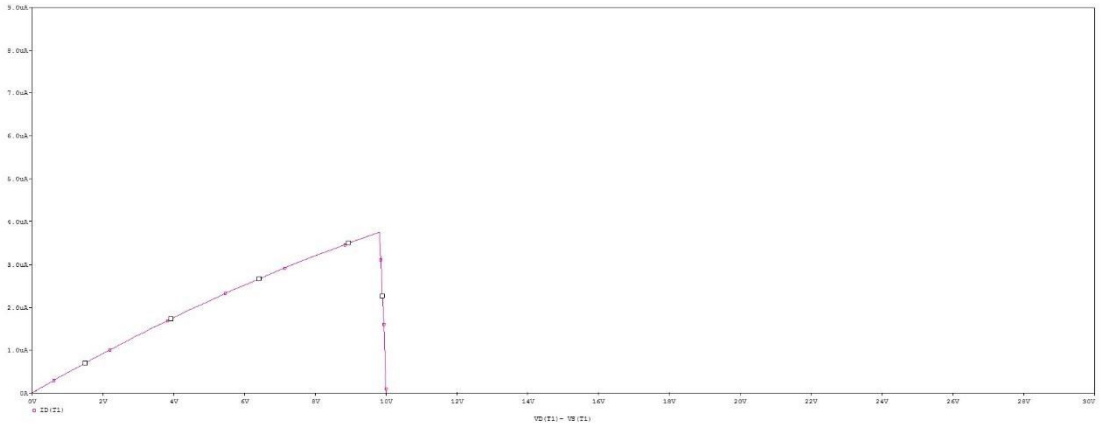
可知V_{gs}影響電流曲線，而V_{ds}影響同一條曲線上的I_d值。



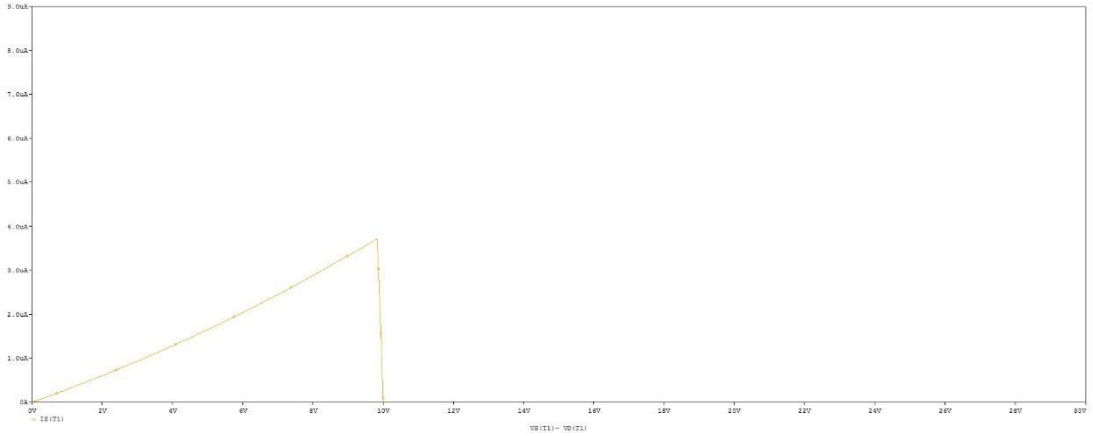
Operation point curve of T1:

Vdata1:

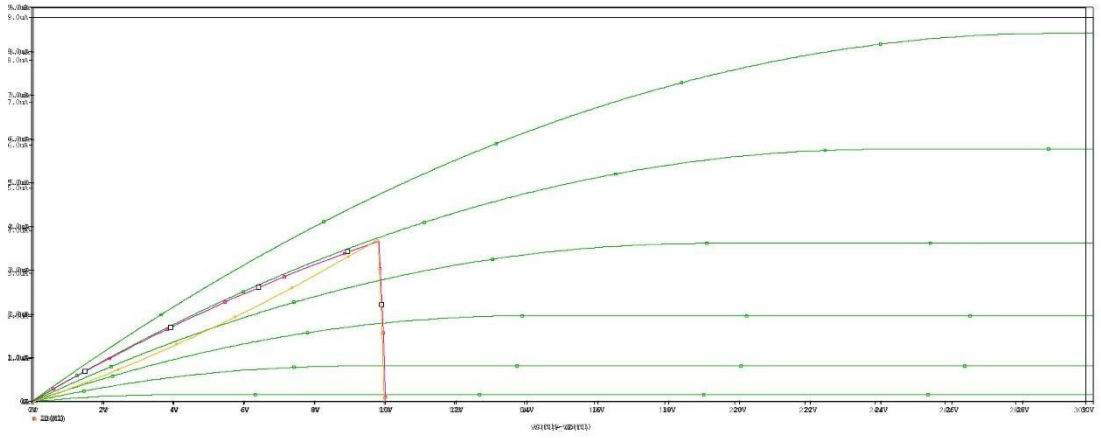




Vdata2:



Ans:



粉色線條為Vdata1，橘色線條為Vdata2

由於TFT的D端和S端是由電壓高低決定，因此電壓高者為D端，低者為S端。

Vdata1為5V可判定為S端，V_{PIXEL}則為D端，由圖可知V_{ds}隨著電容放電由10V降至0V，符合其中一條TFT輸出特性曲線。

Vdata2為15V可判定為D端，V_{PIXEL}則為S端，由圖可知VDS隨著電容充電由10V逐漸降至0V，其中S端電壓由5V上升至15V，V_{gs}則往下掉，可看出此模擬的曲線不會符合TFT輸出特性曲線中的任何一條。

3. Pixel operation

2. Pixel operation

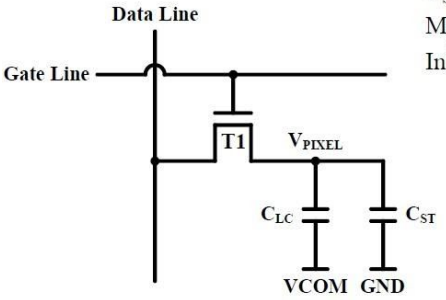
Simulated parameter:

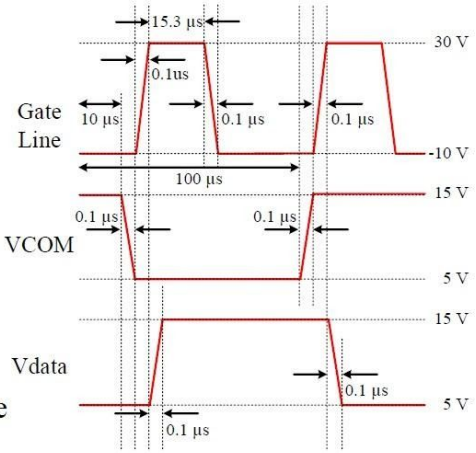
C_{LC} = 0.3 pF

C_{ST} = 0.3 pF

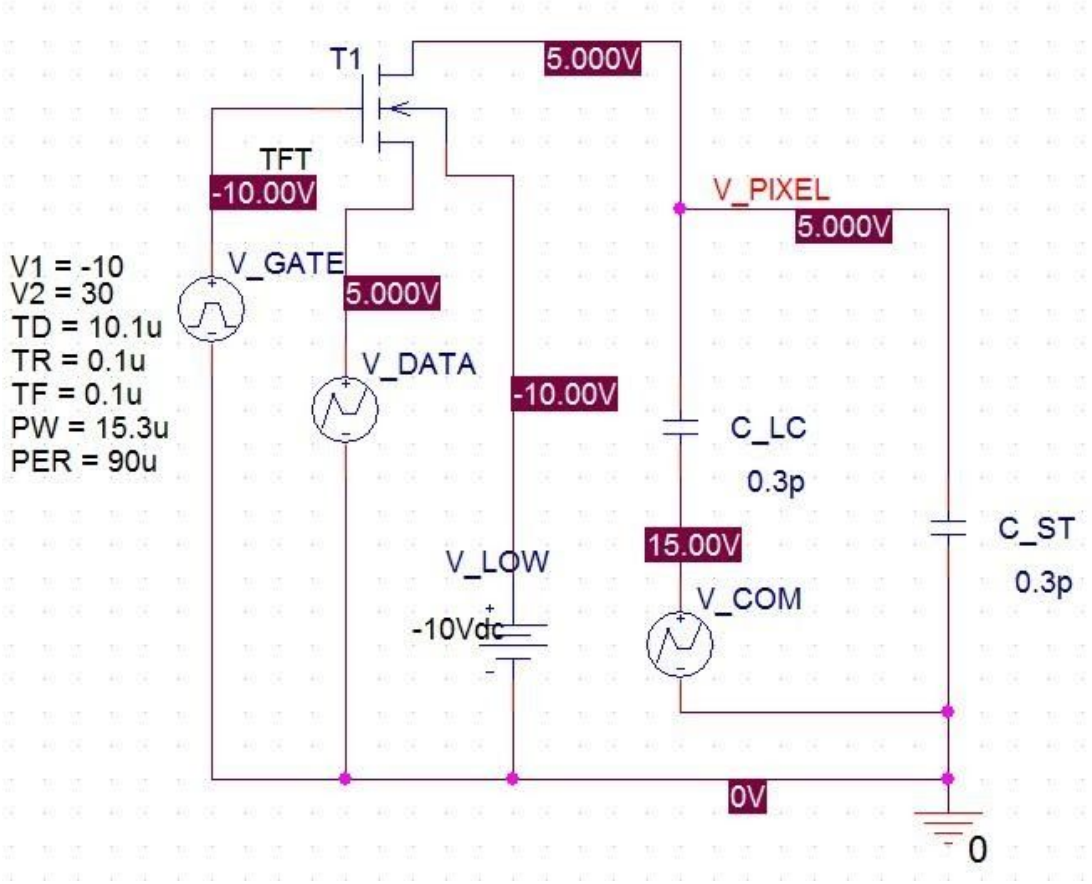
M_{T1} = 10

Initial V_{PIXEL} = 5 V

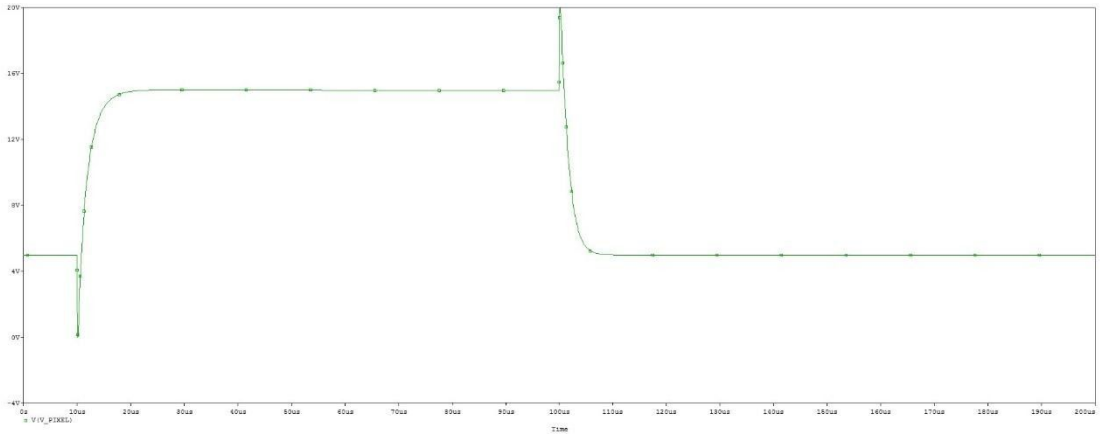




- VCOM is changed frame by frame
- Perform two frames, the first frame is positive polarity and the second is negative polarity
- Provide your simulated waveform of V_{PIXEL}



VCOM is changed frame by frame and perform two frames, the first frame is positive polarity and the second is negative polarity.
Provide your simulated waveform of VPIXEL



前半段電容充電，V_{PIXEL}上升至15V，為positive polarity
後半段電容放電，V_{PIXEL}下降至5V，為negative polarity