ECE 2200L
Introduction to Microelectronics Circuits Laboratory

Experiment 11
Switching Characteristic of BJT

Report

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Objective

To study the large signal switching characteristics of the bipolar junction transistor in time domain as it is driven into ON and OFF states.

Result

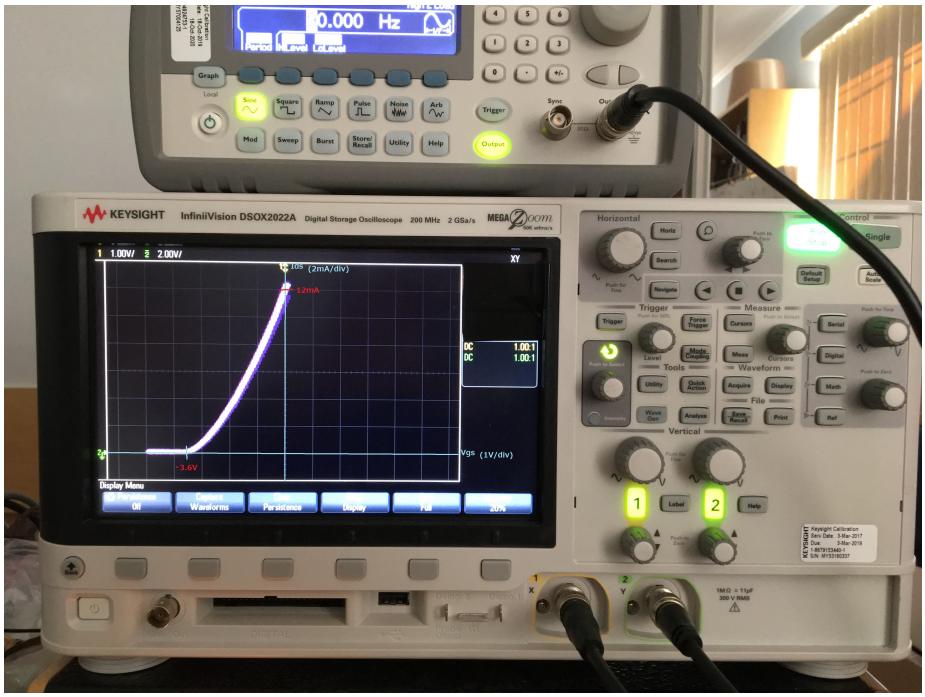

Figure 1: I_{DS} vs. V_{GS} plot from oscilloscope

Figure 1 shows I_{DS} vs. V_{GS} plot assuming $\lambda = 0$, we can thus derive I_{DSS} as follow,

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_p}\right)^2 (1 + \lambda V_{DS})$$

$$I_D(V_{GS} = 0, \lambda = 0) = I_{DSS}\left(1 - \frac{0}{V_p}\right)^2 (1 + 0V_{DS})$$

$$I_D(V_{GS} = 0, \lambda = 0) = I_{DSS} = 12\,\text{mA}$$

Pinch-off voltage V_p is the threshold value of V_{GS} below which the transistor turns off, which we can derived from the plot as the maximum value of V_{GS} that I_{DS} stays 0, which is $V_p = -3.6\,\text{V}$

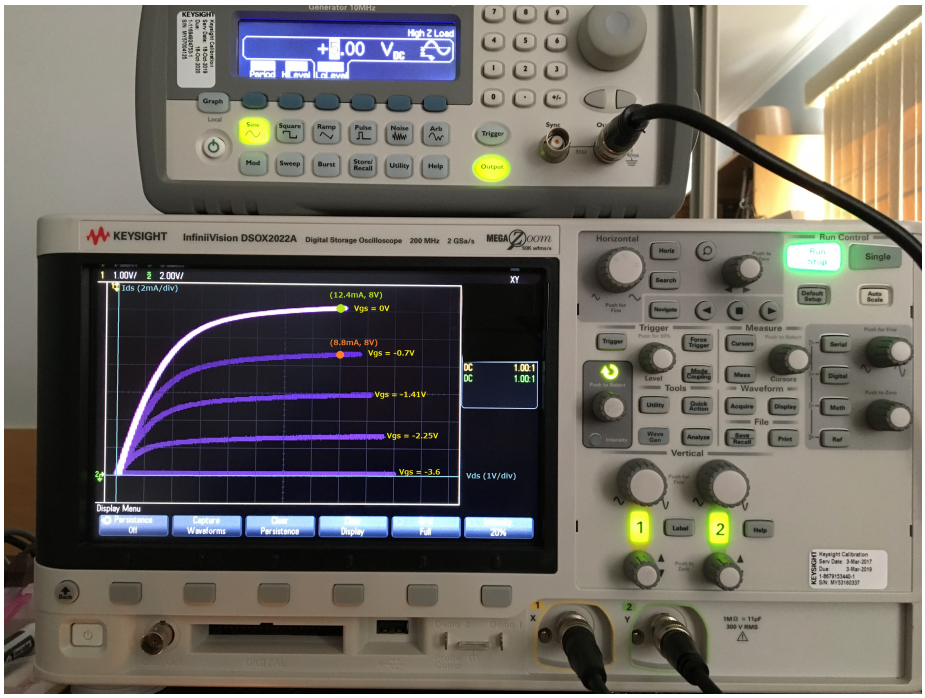

Figure 2: I_{DS} vs. V_{DS} plot from oscilloscope with varying V_{GS} values

λ can be approximated by extending the plot at saturation region as a line to its x-intercept. Using (12.4mA,8V) and (12mA,6.5V), we can approximate V_A to be 38.5 volt and λ to be $0.026\,\mathrm{V}^{-1}$

Figure 2 shows I_{DS} vs. V_{DS} plot from oscilloscope with varying V_{GS} values. From this plot we can then derive I_{DSS} and V_p assuming lambda is $0.026\,\mathrm{V}^{-1}$.

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_p}\right)^2 (1 + \lambda V_{DS})$$

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_p}\right)^2 (1 + 0.026 V_{DS})$$

$$12.4\,\mathrm{mA} = I_{DSS}\left(1 - \frac{0}{V_p}\right)^2 (1 + 0.026(8))$$

$$I_{DSS} = 10.3\,\mathrm{mA}$$

$$8.8\,\mathrm{mA} = 12.4\,\mathrm{mA}\left(1 - \frac{-0.7}{V_p}\right)^2 (1 + 0.026(8))$$

$$\sqrt{\frac{8.8\,\mathrm{mA}}{(1.208)12.4\,\mathrm{mA}}} = 1 - \frac{-0.7}{V_p}$$

$$V_p = \frac{-0.7}{1 - \sqrt{\frac{8.8\,\text{mA}}{(1.208)12.4\,\text{mA}}}}$$
$$V_p = -3.00\,\text{V}$$

Conclusion

As demonstrated above, the values of I_{DSS} and V_p obtained from the above two graph are different from each other which is likely a result of the diffrerent value of λ used to obtain the values.