

ECE 451

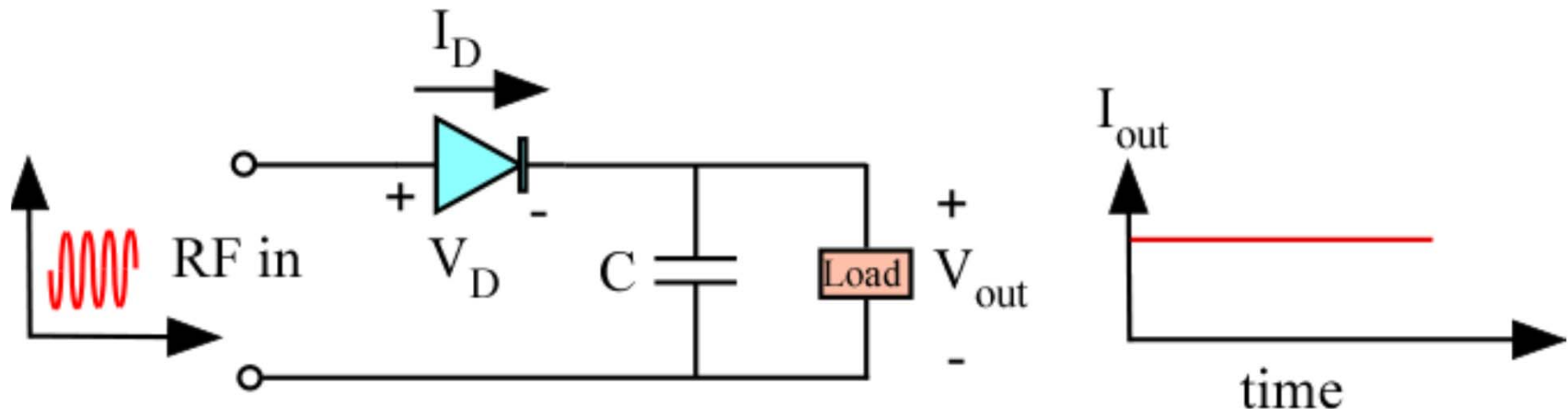
Advanced Microwave Measurements

Square-Law Detector

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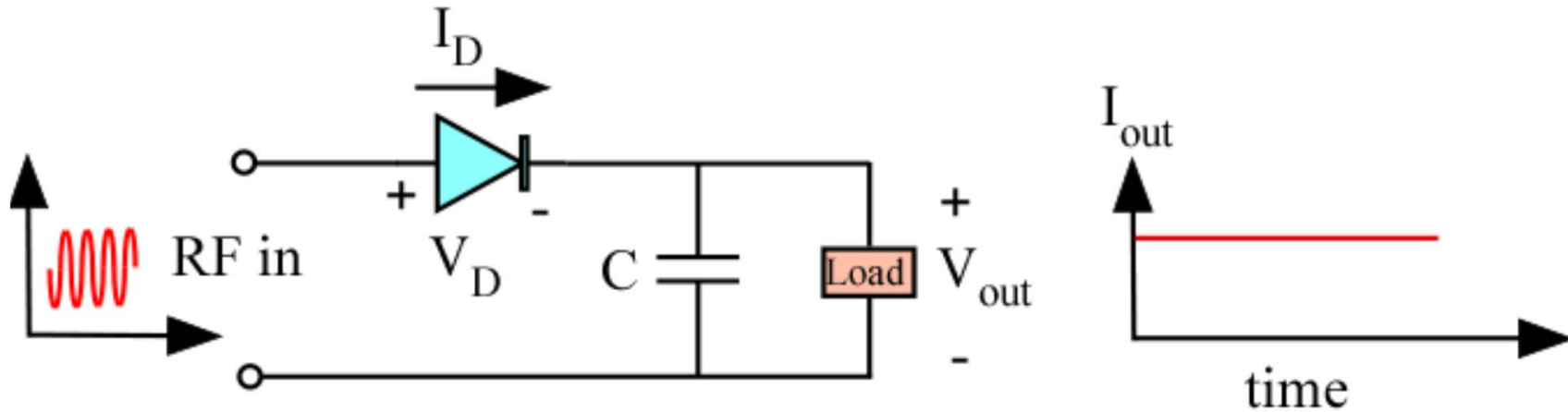
Square-Law Detector

- Detector will receive RF at input and will produce a DC voltage proportional to the magnitude of the RF input



In order to operate properly, diode current must remain in the square-law region

Square-Law Detector

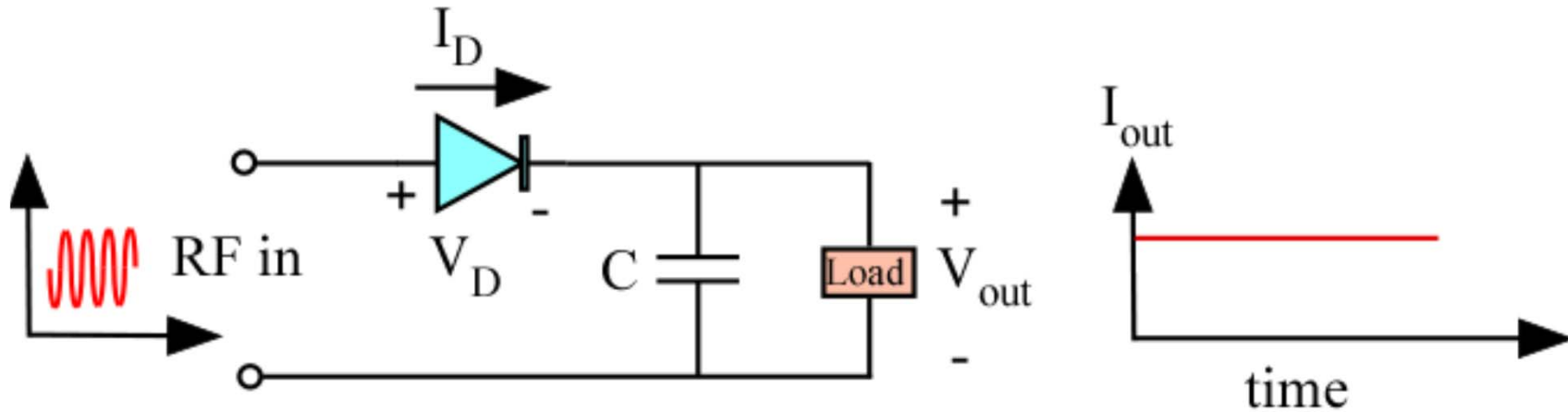


$$I_D = I_S \left(e^{\frac{qV_D}{kT}} - 1 \right) = \left(e^{\frac{V_D}{V_T}} - 1 \right)$$

Expanding

$$I_D \approx I_S \left[\frac{V_D}{V_T} + \frac{1}{2} \left(\frac{V_D}{V_T} \right)^2 + \frac{1}{6} \left(\frac{V_D}{V_T} \right)^3 + \dots \right]$$

Square-Law Detector



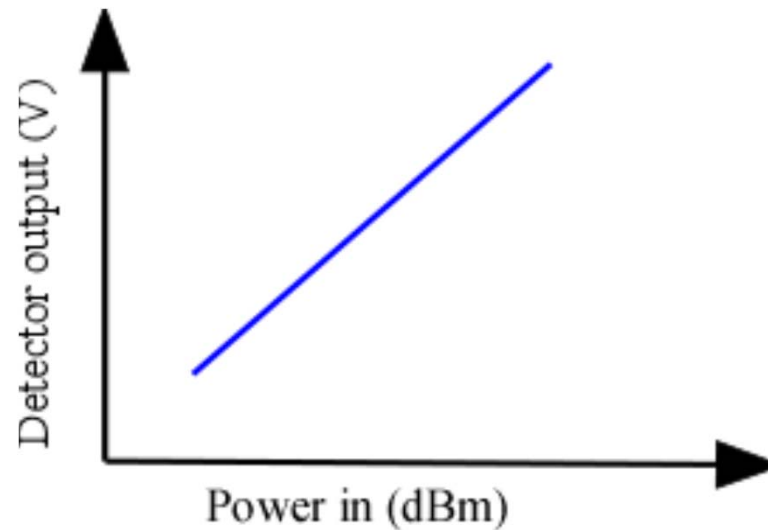
If V_D is small $I_D \approx I_S \left[\frac{V_D}{V_T} + \frac{1}{2} \left(\frac{V_D}{V_T} \right)^2 + \frac{1}{6} \left(\frac{V_D}{V_T} \right)^3 + \dots \right]$ $I_{out} = aV_D$ where a is some constant

If V_D is larger $I_D \approx I_S \left[\frac{V_D}{V_T} + \frac{1}{2} \left(\frac{V_D}{V_T} \right)^2 + \frac{1}{6} \left(\frac{V_D}{V_T} \right)^3 + \dots \right]$ $I_{out} = bV_D^2$ where b is some constant

If V_D is even larger $I_D \approx I_S \left[\frac{V_D}{V_T} + \frac{1}{2} \left(\frac{V_D}{V_T} \right)^2 + \frac{1}{6} \left(\frac{V_D}{V_T} \right)^3 + \dots \right]$ $I_{out} = cV_D^3$ where c is some constant

Square-Law Detector

GOAL: Keep detector operating in square-law range. Then, I_{out} is proportional to V_D^2 and thus proportional to the power input.



Experiment: Perform several measurements of detector output voltage for various levels of RF power input.