Light dependent oscillator

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2018

Aim

* In this experiment, we will design a light dependent frequency oscillator using CMOS inverter IC HCF4007UBE.

Theory and Design Procedure

A practical CMOS inverter does not switch output states instantly as we change the input state. Due to presence of parasitic components r_{on},r_{op}(drain source ON resistance) and c_p it will take a finite non-zero time to charge the output node to V_{DD} or to discharge it to zero volts.

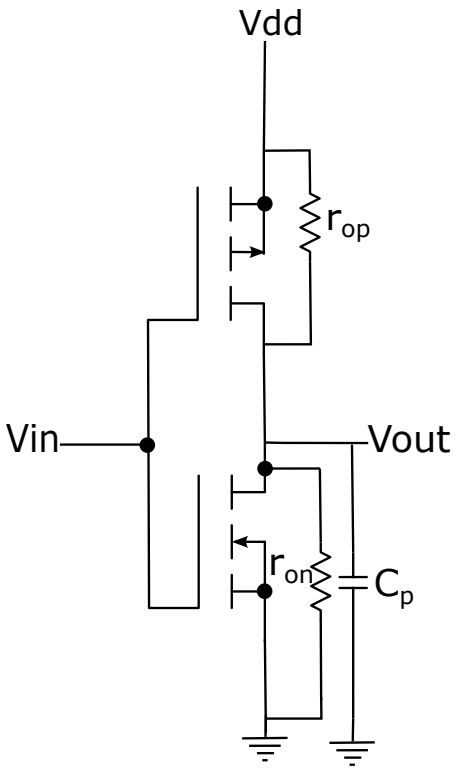


Figure: Practical CMOS inverter

Theory and Design Procedure

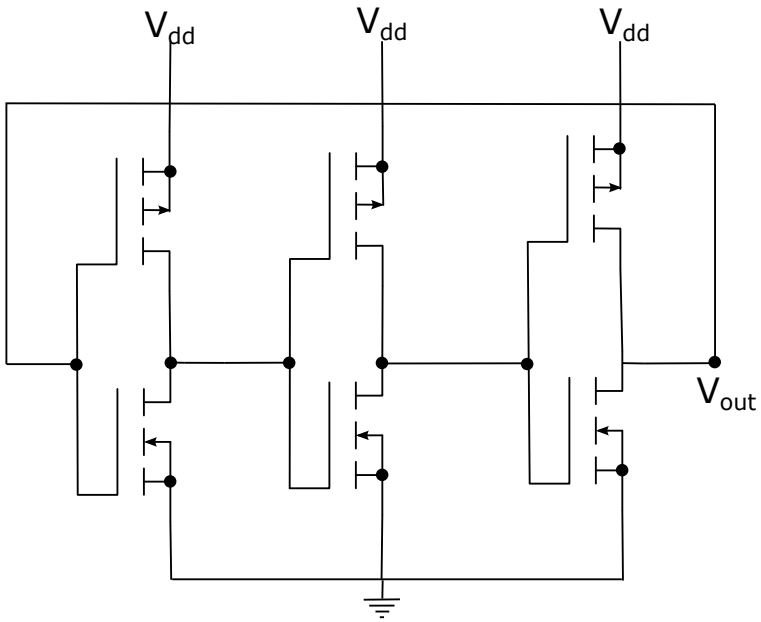


Figure: Ring Oscillator

- We use this delay of inverter to make a ring oscillator.
- Ring oscillator is formed by connecting $'N'$ ($'N'$ should be odd) number of inverters back to back such that input of one inverter is connected to output of previous inverter.
- If delay of one stage is τ, then frequency F of the oscillator is given by

$$F = \frac{1}{2\ x\ total\ delay\ due\ to\ inverters} = \frac{1}{2\ x\ N\ x\ \tau} \tag{1}$$

LDR

Figure: Light dependent resistor

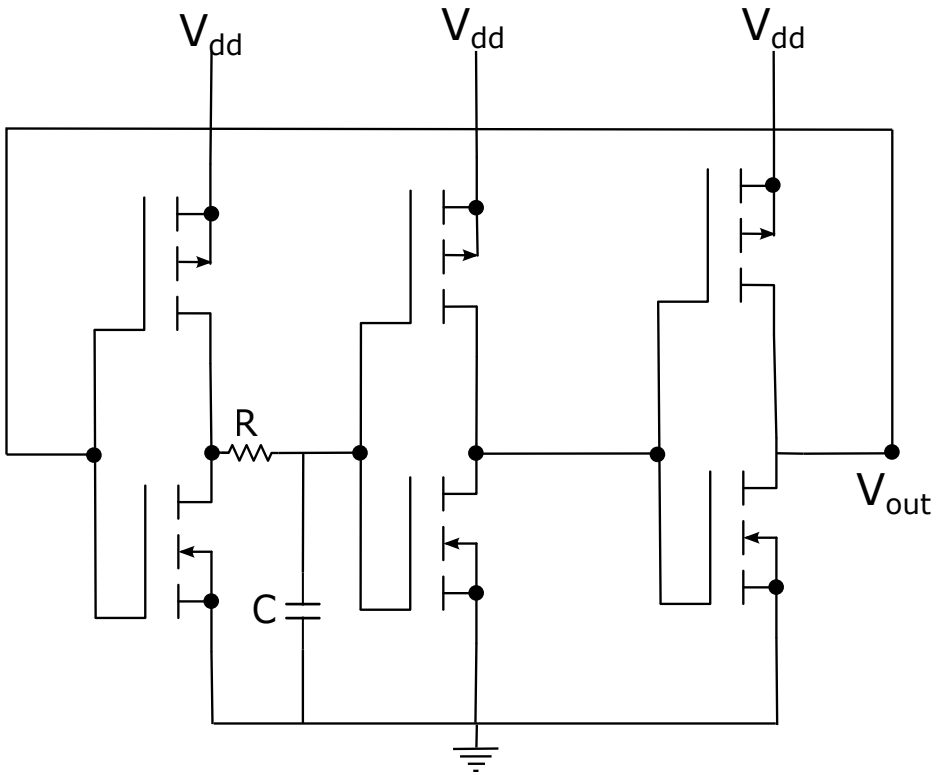
- A Light Dependent Resistor (LDR) is also called a photoresistor or a cadmium sulfide (CdS) cell. The snake like track shown below is the Cadmium Sulphide (CdS) film.
- It works on the principle of photoconductivity.
- The value of the resistance decreases as the intensity of light increases.
- Some of its applications include camera light meters, street lights, clock radios, light beam alarms, reflective smoke alarms, and outdoor clocks.

Part A- Ring oscillator

- Make connections for an inverter.
- Set V_{DD} as 5 V and vary V_{in} from 0 to 5 V and measure V_{out}.
- Plot input-output voltage characteristics of the inverter.
- Make connections for ring oscillator as explained in theory and design procedure.
- Measure frequency of the ring oscillator and calculate delay due to one inverter.
- Make sure that now the V_{DD} is 1.5 V

Part B- Introducing delay in oscillator

- Use a RC series connection (as shown in the figure below) to add delay in one of the inverters in the ring oscillator.
- Use $R = 15K\Omega$, measure frequency of the ring oscillator for $C = 100pF$ and $200pF$.
- Calculate delay for one stage of inverter by comparing time period for the two RC configurations mentioned above(use delay due to RC as $5xRxC$).Compare this delay with the previously calculated delay.



Part C -LDR

- Measure characteristics of LDR in different light settings.
- Replace resistor (R) in the previous circuit of ring oscillator with LDR that has been provided to you.
- Measure different frequencies of oscillator by changing intensity of light on LDR.