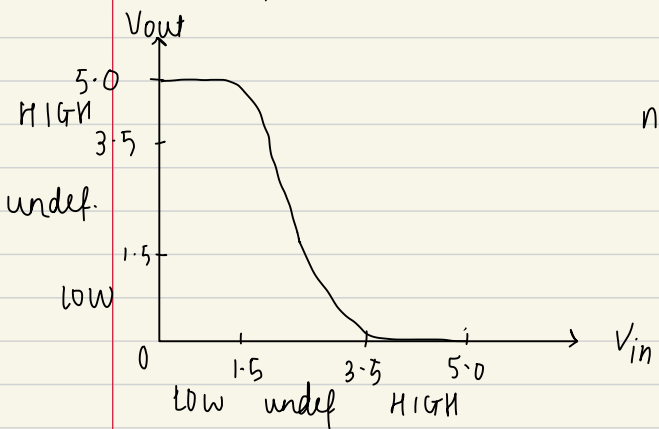
Digital circuits characteristics

- I/O of CMOS inverter (typically)

⇓

not guaranteed.



Char 1 **Voltage parameters**

V_{OH} (min) - minimum O/P voltage produced for logic 1

V_{IH} (min) - minimum I/P voltage to be recognised as logic 1

V_{OL} (max) - max O/P voltage produced for logic 0

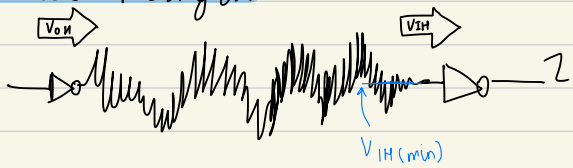
V_{IL} (max) - max I/P voltage to be recognised as logic 0

CMOS

5.0
3.5 ← V_{IH}, V_{OH}
1.5 ← V_{IL}, V_{OL}
0

$V_{OH} \geq V_{IH}$
$V_{OL} \leq V_{IL}$

Char 2 **Noise margin**



- High-state DC noise margin = $V_{OH}(min) - V_{IH}(min)$
- higher the noise tolerence, the better
- low-state DC noise margin : $V_{IL}(max) - V_{OL}(max)$
- higher power supply ⇒ better noise margin
- overall noise margin = min (high state, low-state)
  $V_{OH} - V_{IH}$ $V_{IL} - V_{OL}$

Char 3 **Current Parameters**

- I_{IH} (max) : max current in the input at logic 1.
- I_{IL} (max) : max current that flows into input at logic 0
- I_{OH} (max) = max current flowing from output at logic 1
- I_{OL} (max) = max current flowing from output at logic 0
- In CMOS, current is very small, esp at I/P (1 μA) and for O/P theres a range (0.02 - 29 mA) depending on the family

Char 4 **FAN-OUT**

- specifies the number of standard loads/gates an output can drive
- more gates ⇒ more current you need to have ∴ current parameter ∝ fan-out
- more loads can reduce noise margin (bad) and may increase switching speed
- high state fan-out = I_{OH}/I_{IH}
  low state fan-out = I_{OL}/I_{IL}

char 5 **SPEED**

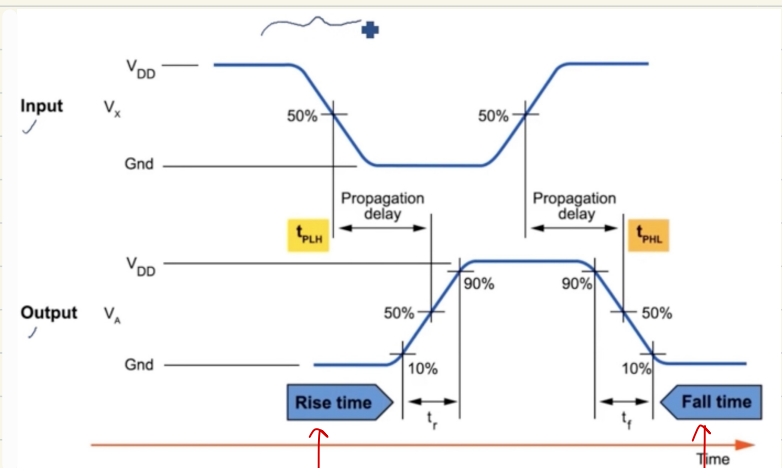
- switching speed measures how much time it takes for the output to switch b/w logic 0 and 1
- shorter, the better

char 6 **Power Dissipation**

- power consumed by the gate or device
- in CMOS, most power is consumed when it switches between 0 and 1 (dynamic power dissipation)
- $P = C V^2 f$ (gets heated)
  - C: constant
  - V: power supply voltage
  - f: switching frequency
- static power dissipation (when its at logic 0, logic 1) is very small.

char 7 **Propagation Delay**

- avg transition delay time for signal to propagate from input to output
- typically in nanoseconds
- t_{PD} or (t_{PHL} & t_{PLH})
  - t_{PHL}: H → L
  - t_{PLH}: L → H
  - change in O/P



- time taken for signal to go from 0-1 (logic)

should be as short as possible